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KEY LAND USE ISSUES FACING EPA

HARBRIDGE HOUSE, INCORPORATED

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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The report identifies key land use issues facing EPA and analyzes those issues in terms of the environmental impacts involved and the projected magnitude of the problems over time. The need to view land use in terms of an intermedia perspective is emphasized. A preliminary analysis is made of broad land use categories, i.e., agriculture, mining silviculture, transportation, energy facilities, and residential, commercial and industrial usage. Land use issues are divided into two subdivisions: general growth pattern and the siting of key facilities. Each of the major land uses is viewed in terms of impact on air, water, and noise pollution levels, and indirect effects such as induced development on surrounding land. Land use variables which reduce adverse environmental impact are cited Several growth issues are discussed: concentration versus dispersion, development patterns, rural-urban interface, nondegradation, critical areas, and new construction. In the area of facility siting, the study focuses upon projected demand, supply and land use patterns, primary and secondary environmental impacts, and land use control measures to abate adverse environmental impact. The report is documented in attached appendices.

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Prepared for the

Office of Planning and Evaluation
ENVIRONMENTAL PROTECTION AGENCY
Washington, D.C.

February 1974

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Submitted by

Harbridge House, Inc.
11 Arlington Street
Boston, Massachusetts 02116

To

Office of Planning and Evaluation
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

February 1974

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

SUBJECT: Key Land Use Issues Facing the Environmental Protection Agency

TO:

The following report has been prepared for use by the Environmental Protection Agency to assess those land use issues which either because of projected trends, patterns, timing and/or magnitude of their impact on the environment should be of immediate concern to policy makers within the Agency. In some of the areas further research is required before the problem can be translated into appropriate Agency action. Other issues can be reviewed immediately for the development of agency policy and/or action through program implementation. An analysis of the authority of the Agency to influence and control land use will be analyzed in another report now under preparation. It is hoped that the two reports can support agency-wide dialogue on land use and identify alternative ways to deal with EPA's land use concerns.

This document has been prepared for use by both EPA headquarters and regions. Obviously the relative importance of many of the issues covered in the text and support materials varies from region to region. We have included only those materials which would be of wide interest. Additional materials are available on request for certain topic areas.

The Office of Planning and Evaluation welcomes your comment.

Respectfully,

Paul Brands
Deputy Assistant Administrator
for Planning and Evaluation

Attachments

10

CONTENTS

List of Exhibits iii

Part I: Introduction 1
  Study Objective 1
  Scope of Work 6

Part II: General Growth and Development Issues 11
  Introduction to Part II 11
  Concentration Versus Dispersion 12
    Demographic Trends 12
    Development Trends 17
    Transportation and Wastewater Treatment 26
    Indirect Sources 40
    New Towns 60
  The Rural-Urban Interface 67
    The Problem 67
    Other Elements Affecting Rural Land Use 77
  Non-Degradation 80
    Introduction 80
    Regional and Area Land Use Trends and Non-degradation 81
    Land Use and Significant Deterioration 92
  Areas of Critical Environmental Concern 94
    The Coastal Zone 96
    Wetlands other than Coastal 98
    Floodplains 98
    Unsuitable Soils 100
    Other Cases 100
    Arid and Semiarid Regions 101
  New Construction 104

Part III: Siting Issues 110
  Approach 110
    Definition 110
    Facility Selection 110
  Methodology 111
  Siting Issues by Type of Facility 113
    Airport Siting 113
    Highway Siting 115
    Wastewater Treatment Facilities 117
    Landfill 119
    Industrial Siting 120
    Energy Facilities 122
  Siting Issues by Type of Environmental Impact 126
    Air Pollution 126
    Water Pollution 129
    Noise 136
    Solid Wastes 138

Part IV: Concluding Remarks 140

CONTENTS (Cont'd)

APPENDICES

Page

A. List of Abbreviations 141

B. Airport Siting 142

C. Highway Siting 168

D. Residential Development 209

E. Agricultural Land Use and Forestry/Silviculture 235

F. Energy Facilities

1. Fuel Minerals Land Use 277

2. Electricity Generation and Transmission Facilities Siting 306

3. Petroleum Refinery Siting 327

4. Tank Farm Petroleum - Storage Vessel Siting 351

G. Bibliography 363

LIST OF EXHIBITS

Page

I Percent Land Use Distribution in the United States 12

II Mean Percentage of Land Use in Selected Cities by Size 21

III Environmental Effects of Alternative Housing Patterns 22

IV Land Consumption: Conventional Versus Cluster 23

V Land Use: Conventional Versus Open Space Subdivision 25

VI Representative Transportation Emissions 31

VII Indicators for Types and Sizes in Shopping Centers 42

VIII Siting Patterns of Shopping Centers for Selected SMSA's 43

IX Map of Airports: 25,000-50,000+ Commercial Operations Per Year 50

X Planned New Towns With Population Greater Than 50,000 61

XI Summary Characteristics of HUD Financed New Communities 63

XII Relationship Between Farm Size and Cost of Capital and Other Purchased Inputs 73

Base Maps: SMSA Changes, 1950-1971 83
Overlay: Relative Water Pollution 84
Overlay: Relative Air Quality 85
Overlay: New Plant Locations 86
Overlay: New Power Plant Locations 87, 88

XIII Sources of Water Pollution 131

XIV Projected Acreage Requirements of Cooling Systems for 1000 MW Power Plants 132

XV Cities With Significant Aircraft Noise Disturbance 137

XVI Summary of Radioactive Waste Projections 139

LIST OF EXHIBITS IN APPENDICES

		Page
B-I	Historical and Projected Growth in Air Passenger Miles	142
B-II	Historical and Projected Growth in Air Freight	142
B-III	Summary of Costs for Airport Development Program 1972-81	143
B-IV	New Airport Facilities Needed by 1980	143
B-V	Map of Major Hub Airports	146
B-VI	Eligible Aircraft per 1,000 Square Miles by State	147
B-VII	Eligible Aircraft per 10,000 Population by State	148
B-VIII	Comparison of Emission Densities for Airports vs. Urban Areas (1970, 1975, 1980)	153
B-IX	Comparison of Aircraft Emission Control Methods	157
C-I	Comparison of 1968 Miles of Highways and Daily Vehicle-Miles of Travel on Functional Systems With the Estimates for 1990	170
C-II	Projected Distribution of Rural and Urban Needs	172
C-III	Motor Vehicular Emissions: 1969 and 1980	175
C-IV	Feasibility Ratings for Various Uses of Air Space Above and Below Freeways	181
C-V	Control Techniques for Mobile Source Emissions	183
C-VI	Techniques for Improving Traffic Flow, for Reducing Pollution Concentration, and for Reducing Auto Traffic	186
C-VII	Effect on Arterial Investment Requirements of Various Alternatives	194

List of Exhibits in Appendices (Cont'd)

		Page
C-VIII	Energy and Price Data for Urban Passenger Transport	198
C-IX	Modal Passenger Capacities per Lane or Track	199
C-X	Federal Highway and Transportation Expenditures in Urban Areas 1957-70	201
C-XI	Modal Split and Modal Travel Preference: Selected Metropolitan Areas	202
C-XII	Number of Transit Systems by Ownership	203
C-XIII	Increase in Average Weekday Person Trips by Mode (1970-90)	203
C-XIV	Representative Transportation Emissions	206
C-XV	Selected Sound Levels by Source	208
D-I	Comparison of Neighborhood Housing Patterns	211
D-II	Acreage for New Towns by Region	212
D-III	Densities by Residential Type	212
D-IV	Problems Associated with Various Density Thresholds	213
D-V	Population and Land Area of Urban Regions: 1920-2000	214
D-VI	Community Land Budget	215
D-VII	Neighborhood Development Patterns: Air Pollution	217
D-VIII	Community Development Patterns: Air Pollution	219
D-IX	Neighborhood Development Patterns: Water Pollution and Erosion	220
D-X	Community Development Patterns: Water Pollution and Erosion	221
D-XI	Solid Waste Patterns per Capita per Day for Various Housing Patterns	222

List of Exhibits in Appendices (Cont'd)

		Page
D-XII	Community Development Patterns: Noise	223
D-XIII	Community Development Patterns: Vegetation and Wildlife	224
D-XIV	Emissions from PUD's Vehicles in Pounds per Weekday	225
D-XV	Reductions in Atmospheric Loading per 10,000 Cars and, in Parenthesis, the Emissions Generated by the PUD's Automobiles	226
D-XVI	Average Emissions from Gasoline-Powered Vehicles	227
	Average Speed Adjustment Factors for Automobile Exhaust Emissions	
D-XVII	Subdivision Costs, Conventional vs. Cluster	232
E-I	Selected Food Products: Projections 1971-80	235
E-II	Harvested Acreage of Principal Crops in United States for 1968, 1969 and 1970	238
E-III	Channel Enlargement Effects of Land Uses in a One Square Mile Basin	240
E-IV	Contamination of Water by Fertilizers	241
E-V	Contamination of Water by Pesticides	242
E-VI	Wastes Generated from Various Sources	245
E-VII	Pollution Loadings of Selected Agricultural Processing Industries	251
E-VIII	Nationwide Air Pollution Emission Estimates from Forest Fires in 1970	269

List of Exhibits in Appendices (Cont'd)

Page

F-I Demand for Coal 277

F-II The Demand for United States Coal Resources by Major Consuming Sectors, 1971 Actual, with Projections to the Year 2000 277

F-III Coal Production - 1970 278

F-IV Petroleum Demand 279

F-V Domestic Petroleum Consumption 279

F-VI Estimated Petroleum Supply Schedule, 1971 Actual with Projections to the Year 2000 280

F-VII Natural Gas Demand 281

F-VIII Natural Gas Consumption 281

F-IX Estimated Gaseous Full Supply Schedule, 1971 Actual with Projections to the year 2000 282

F-X U.S. Total Gross Consumption in Standard Physical Units by Major Sources and Consumer Sectors 283

F-XI U.S. Total Gross Consumption in Trillions of BTU's by Major Sources and Consuming Sectors 284

F-XII Emissions, Pounds Per Barrel of Oil Discharged. 286

F-XIII Coal - Domestic Reserves 301

F-XIV Natural Gas- Domestic Reserves 301

List of Exhibits in Appendices (Cont'd)

		Page
F-XV	Electric Utility Industry-Installed Generating Capacity	307
F-XVI	Fossil Fuel Inputs to the Electrical Sector, 1971 Actual, and Projections to the Year 2000	308
F-XVII	National Power Survey	309
F-XVIII	Nuclear and Fossil-Fuel Plant Acreage	310
F-XIX	Circuit Miles of Transmissions Lines by U.S. Region	310
F-XX	Emission of Sulfur Dioxide From Conventional Fuel-Fired Power Plants	313
F-XXI	Emission of Nitrogen Oxides From Large Boiler Furnaces	313
F-XXII	Emission of Particulate Matter From Coal-Fired Boiler Furances	314
F-XXIII	Ecological Imbalances Caused By Thermal Pollution	315

I. INTRODUCTION

A. Study Objective

The objective of this report is to identify key land use issues facing the U.S. Environmental Protection Agency (EPA) and to analyze those issues in terms of the nature of the environmental impacts involved and the projected magnitude of the problems over time.

In approaching a study of this kind, the first step required is to determine the relationships between land use and environmental quality. Indeed, a legitimate question that may be raised is, "Why should EPA be concerned with land use; doesn't it have enough to do in controlling air, water and noise pollution, and solid waste accumulation?" The answer to this question may be seen as analogous to a doctor's role in upholding the Hippocratic oath. If a doctor merely treats the symptoms rather than the disease itself, the long-term prognosis for the patient may not be favorable. Today's modern medicine, in fact, emphasizes "preventive medicine" or the process of building up the body's natural defenses with exercise, proper diet, innoculations, and so forth.

In a similar way, the Natural Environmental Protection Act of 1969 sets forth as its purpose the achievement of a balance of "productive and enjoyable harmony between man and his environment."[1] In essence, the achievement of this harmony requires more than treating the symptoms or sources of pollution, but also establishing a balance between the needs of man and the utilization, conservation and preservation of the environment. Senator Henry Jackson has addressed this point in his statement opening the 1971 hearings on the National Land Use Policy and Planning Assistance Act:

---

[1] From the "Statement of Purpose" of the National Environmental Protection Act of 1969 (PL 91-190).

> If we are to develop and implement a design for a better America, I believe it is essential that the nation establish a National Land Use Policy. We have made important progress in some areas in recent years toward introducing environmental values into governmental decisions. We must now undertake the far more challenging task of long-range planning to insure a proper balance between the nation's resource requirements and our national environmental goals. It is essential that we develop a framework within which the full spectrum of proposals to utilize environmental resources can be balanced against one another and measured against the demands they impose upon the environment. To do this, we need a focal point upon which we can compare alternative proposals to achieve our goals. This focal point should be the use of land.[1]

The relationships between the environment and land use work in two directions. Man's use of the land can impact environmental quality, while control of environmental quality can affect land use. The complexity of the first case is illustrated by the following passage from the Fourth Annual Report of the Council of Environmental Quality.

> The broadest, and probably the most significant, land-related problems are secondary consequences of land use patterns and practices. These patterns and practices create problems such as pollution, which in turn endanger man and his environment.
>
> Patterns of land use are a major determinant of pollution levels in any area. The greater the distances that must be traveled between home, workplace, and shops, the more air pollution will be generated by automobile travel. Significant water pollution problems can be generated by development on lakeshores or by placement of septic tanks in unsuitable soil. Many forms of industrial pollution may be reduced by siting a plant so that its wastes can be productively utilized by a neighboring plant. For all types of pollution the degree of concentration of principal pollution sources is a key factor in the level of pollution to which the population is exposed.

---

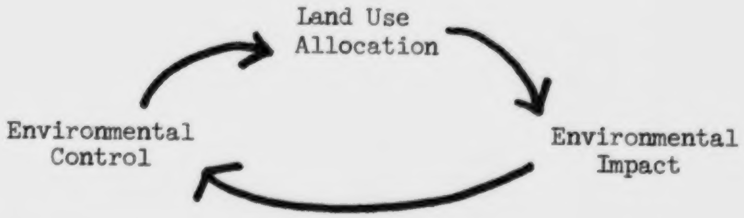
[1] U.S. Senate. Hearings before the Committee on Interior and Insular Affairs on S. 632 and S. 992 (92nd Congress. Part 2, June 22 & 23, 1971), p. 270.

> Land use patterns also play a significant role in the consumption and availability of natural resources. Pollution often represents misplaced resources. Thus, for example, the added air pollution generated because of longer travel distances also means wasted gasoline. Land development can lead to reduced water supply (by building over ground water recharge areas, for example), reduced soil capability for growing crops (by erosion and poor farming practices), and reduced ability to extract mineral resources (by building in areas where such resources are found).[1]

The second case exists when EPA programs and policies affect land usage; for example, environmental policies that increase disposal of waste on the land:

> Air pollution corrected by installing wet scrubbers and electrostatic precipitators creates a sludge and flyash disposal problem on the land or in the water. Treatment plants can purify sewage, but must later dispose of the residual sludge on the land or in the ocean. Unused pesticides and toxic materials once dumped in rivers and streams are now disposed of on the land. Municipal solid waste previously incinerated is now disposed of in landfills. Slash once burned now constitutes a major solid waste problem in our forests.[2]

Diagramatically the two processes can be seen as a circular cause-effect relationship, where a land use allocation results in a certain type of environmental impact which EPA attempts to regulate, leading to a new set of land use allocations.



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[1] September 1973, page 317.

[2] Youth Advisory Board, Land Use and Environmental Protection (Draft, Summary Report, May 1973), pp. 10-11.

Accompanying the Reorganization Plan establishing the Environmental Protection Agency was the Presidential Message stating:

> Responsibility for anti-pollution and related programs is now fragmented among several departments and agencies, thus weakening our overall Federal effort. Air pollution, water pollution and solid wastes are different forms of the same problem, and it becomes increasingly evident that broad systems approaches are going to be needed to bring our pollution problems under control. (Emphasis added.)

Since EPA's mandate is to support and enhance environmental quality in its totality, we have attempted to examine as far as possible, within the study limitations, the full cycle of the cause-effect relationship.

While the above discussion attempts to highlight some of the links among EPA policies, environmental quality, and land use, a second reason for EPA to be looking into its role vis-a-vis land use issues is the question of timing. Historically, land use has been a local matter. In recent years, however, there has been growing concern over the parochial nature of local decisions that fail to take into account impacts and implications extending beyond their local political boundaries. In terms of assessing impacts of regional concern, the question as to what kind of coordination should take place in planning, review, and implementation of policies affecting land use impacts that cut across air quality control regions (AQCR), water basins, and political boundaries is now open.

Timing is also important in terms of the rapid change in land use patterns and pressures:

> Today, the Nation as a whole is beginning to experience the pressures once felt only in its major population centers. In all parts of the country, conflicting demands over limited land resources are placing severe strains upon economic, social, and political institutions and processes and upon the natural environment -- farmers' groups oppose real estate developers; environmentalists fight the electric power industry; homeowners collide with highway planners; the

> mining and timber industries struggle with conservationists; shoreline and water recreation interests are pitted against oil companies; cities oppose the states; and suburbs oppose the cities . . . . Sobering statistics suggest that, unless our land use decision-making processes are vastly improved at all levels of government - local, State, and Federal - the United States will be faced with a truly national land use crisis. Over the next 30 years, the pressures upon our finite land resource will result in the dedication of an additional 18 million acres or 28 thousand square miles of undeveloped land to urban use . . . . In short, between now and the year 2000, we must build again all that we have built before. We must build as many homes, schools, and hospitals in the next three decades as we built in the previous three centuries.[1]

Concern over pressure on the land has been given expression in the several bills for a National Land Use Policy and Planning Assistance Act (LUPA). Under the proposed provisions of LUPA, EPA will participate as a member of the Interagency Advisory Board on Land Use Policy, and as one of three agencies with special review responsibilities of the state land use programs. In order to play a proper role in ensuring that there is a balanced evaluation of the trade-offs and alternatives involving environmental quality, EPA must identify and clarify its own position with respect to these issues.

In summary, the interrelationships between land use and environmental quality, the need to see land use in terms of an intermedia perspective, and the timing considerations especially vis-a-vis establishing a proper foundation for implementation of LUPA, are all strong points in favor of EPA identifying and addressing significant land use issues.

---

[1] U.S. Senate, Report of the Committee of Interior and Insular Affairs on the National Land Use Policy and Planning Act (June 7, 1973), pp. 35-37.

B. Scope of Work

In order to meet the requirements of the study objective, described in the preceding section, four tasks were undertaken. These were:

- Identify current land use problems facing EPA
- Determine trends and projections impacting the nature and magnitude of future land use problems
- Develop a methodology for assessing the relative importance of the issues vis-a-vis EPA's mandated concerns and responsibilities
- Identify gaps in information and/or policy that preclude a complete assessment of any land use issue at this point in time.

Each one of these tasks is discussed more fully below.

First, however, the approach taken to identifying both present and future land use issues, deserves comment. In order to maintain an open and flexible orientation for identifying the issues, a preliminary analysis was made of broad land use categories, i.e. agriculture; mining; silviculture; transportation; energy facilities; recreation and residential; commercial, and industrial usage. Data was gathered on nationwide patterns for these types of land use, the nature and magnitude of adverse environmental impact associated with each, and EPA responsibilties with respect to monitoring or controlling these impacts. The purpose of preparing this overview was to provide a backdrop for identifying present and future issues and to prevent early exclusion of a potential topic of interest due to oversight or lack of available information.

1. Identify Current Land Use Problems Facing EPA

During this task several approaches were used to gather the relevant information. Studies underway and reports completed under the auspices of various offices within EPA were examined. Interviews were conducted with key persons throughout the agency. A review was made of land use projects and programs being carried out by other governmental bodies (local, state, and federal), by colleges and universities, and by privately sponsored groups. Reports of the hearings before Congressional committees on the proposed bills for a National Land Use Policy and Planning Act were also covered.

As a result of these efforts, it became evident that land use issues reflecting environmental concern could be broken down into two broad subdivisions: general growth patterns and siting of certain key facilities, including:

- Transporation facilities (highways and airports)
- Energy facilities (petroleum refineries, tank farms, transmission lines, and power plants)
- Wastewater treatment facilities
- Indirect sources (new towns, regional shopping centers, sports stadiums, large-scale recreational complexes)
- Industrial facilities (especially those falling under New Source Performance Standards and hazardous pollutant sources)

2. Determine Trends and Projections Impacting the Nature and Magnitude of Future Land Use Problems

Each one of the major land uses covered in the original overview, together with facilities identified in Task I as having significant siting problems were analyzed using the following format.[1]

---

[1] Growth issues were not analyzed further at this point, but during a later phase using information generated out of the analyses discussed under Task 2

DEMAND/NEED (Projected to 1980 & 1990)

- Nationwide
- In terms of land consumption
- In terms of regional concentration

ENVIRONMENTAL IMPACT

- Direct
  - --Air pollution
  - --Water pollution
  - --Noise pollution
  - --Ecological imbalance
  - --Visual pollution
- Indirect (e.g. induced development on surrounding land, increased auto traffic, etc.

NON LAND USE VARIABLES THAT CAN REDUCE THE ADVERSE ENVIRONMENTAL IMPACT

- New Technology
- Non land use changes in operations and/or management

LAND USE VARIABLES THAT CAN REDUCE THE ADVERSE ENVIRONMENTAL IMPACT

The results of these analyses are found in Appendices B-E. The first two parts of the above format were designed to obtain the necessary projections of the magnitude of the land use problem and its adverse environmental impact over the next 10 to 20 years. Parts 3 and 4, on the other hand, were designed to help determine whether the problem was one that required either a land use approach or technique of control for its amelioration or solution. For example, in the case of airports could the adverse environmental impacts be controlled through the application of technology (e.g. air pollution control devices and acoustical systems for aircraft) or management adjustment in operations (e.g. retrictions on allowed idling time on the ground or changes in the direction and angle of take-offs and landings), or were there impacts such as those related to induced commercial development on surrounding land and increased automobile traffic that required the application of land use controls and siting standards?

3. Develop a Methodology for Assessing the Relative Importance of the Issues Vis-a-vis EPA's Mandated Concerns and Responsibilities

Breaking land use issues into sub-issues presented problems. There are not only a large number of land use sub-issues with associated environmental impacts, but also each issue can assume a variety of forms and can be approached on different levels of specificity. It was recognized that a methodology had to be established that would assist EPA in determining which issues required immediate attention.

For this purpose a set of criteria were used to evaluate each issue with respect to its importance to EPA. The criteria selected were:

--Time (immediacy and duration of environmental impact; urgency of requirement for EPA action);

--Irreversibility (permanence of environmental impact);

--Present or potential conflicts (with stated national policy; with institutional interests--for example, public authorities such as TVA or local port authorities; with state and local government plans, powers, and interests);

--Magnitude of the impact (estimated ecological effects; impact on air quality, water quality, noise; potential costs);

--Extent of the impact (quantity of land involved; urban versus rural locations);

--Extent of chain effect (for example, impact on water cycle);

--Estimated demand for land (for airports, highways, energy facilities, etc.).

4. Identify Gaps in Information and/or Policy That Preclude a Complete Assessment of a Particular Land Use

During all phases of the study, but particularly during Task 3, the lack of certain types of data and information prevented an equivalent scope of analysis for all the issues. Whenever these gaps became apparent or the lack of policy decisions meant that projections of future events were open to a large amount of speculation, note was made of these. During Task 4 these findings were evaluated in terms of suggestions for areas of further study and research by EPA.

II. GENERAL GROWTH AND DEVELOPMENT ISSUES

A. Introduction

Growth may be defined in many ways. There is growth in population, in family units, in gross national product (GNP), in industrial output, in employment, in value added and so forth. In terms of land use, growth can be further defined in terms of urbanization and/or new developments. In this latter context, a review of recent literature reveals increasing concern with concepts such as "no growth," limited growth," "managed growth," and "induced growth."

In this study we have focused upon several growth issues related to:

- Concentration versus dispersion
- Development patterns
- Rural-Urban Interface
- Nondegradation
- Critical areas
- New construction

The growth issues are considered as being distinct from siting issues (discussed in Part III to this report) in that the latter are the result of conscious individual decisions to place a facility in a specific location, whereas the former are the synergistic response - both conscious and unconscious - to a series of siting decisions.

The presentation of the growth issues listed above highlights pertinent trends and facts that are useful in identifying the sub-issues of greatest importance to EPA. There is a certain degree of overlap among the growth issue categories, requiring a somewhat arbitrary assignment of the discussion topics found under each subheading. Consequently, an effort has been made to provide cross references at critical points to help guide the reader.

B. Concentration Versus Dispersion

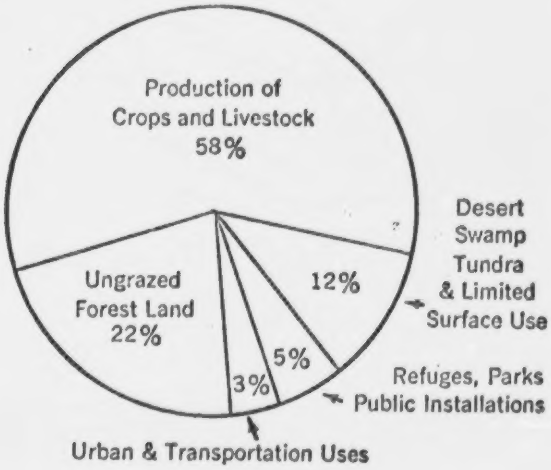
1. Demographic Trends

Exhibit I shows the approximate percentage distribution of land use in the United States at the present time. On the three

Exhibit I

Land Use in the United States

Total Acres 50 States—2.3 Billion



Source: U.S. Senate. Hearings Before the Committee on Interior of Insular Affairs on National Land Use Policy (July 8, 1970), p. 531. Forest Land includes areas which have been clear-cut but are reserved for replanting.

percent of our land devoted to urban and transportation use lives three-quarters of the population. It is the intense concentration of population that is at the heart of most of the growth - related issues.

The U.S. Bureau of Census divides the population into rural and urban components. The urban sector of the population includes all persons living in incorporated or unincorporated places of 2,500 or more and residents of "urbanized areas". An urbanized area generally consists of a city of 50,000 or more, plus the residents of the closely built-up areas adjoining the city, whether they are incorporated or not.

The transformation of the United States from a rural to an urban nation is well known:

> Starting with about five percent of the population in urban areas at the time of the first census, the urban areas grew more rapidly during each of the decades as marked by the census. The half-way mark was crossed about the time of World War I. The 1970 census shows that the urban portion now includes almost three-fourths (73.5 percent) of the total population. It has been 69.9 percent in 1960. It could be said that in 1960 about 70 percent of the total population lived on about one percent of the land area. The relationship may not have changed much since 1960. The boundaries of an urbanized area expand as the built-up area itself expands.[1]

But even more than an urban nation, we are rapidly becoming a suburban nation. According to G.H. Brown, Director of the U.S. Bureau of Census, between the 1960 and 1970 censuses, central cities as a whole grew only about five percent, while the suburban rings soared in population by approximately 28 percent. The balance between central cities and suburban rings has clearly shifted since 1960. At that time, suburban areas had slightly fewer people than the central cities. Since then, more than a half of the people in our metropolitan areas live outside central cities and every indication is, according to Mr. Brown, that this fraction will grow. [1]

---

[1] Conrad Taeuber, "An Overview of the Problems of Density" in Density: Five Perspectives, (An Urban Land Institute Special Report), 1972, p. 13.

If current trends continue by the year 2000, five-sixths of our population is expected to live in urban regions. Population density within the metropolitan regions, however, is expected to decline rather than increase due to the expansion of urban land area. Eighteen new metropolitan areas have been added to the census rolls since 1960, while the land area of several other metropolitan areas also has expanded considerably since that time. As a result of this expansion process, population per square mile in urbanized areas declined from 6,580 in 1920, to 4,230 in 1960 and is expected to decline to 3,732 by the year 2000.

The uneven rate and magnitude of urban "sprawl" has led to some difficulties in distinguishing between urban and rural areas. To overcome problems in classification, beginning in 1950, the U.S. Bureau of the Census has adopted the concept of "urbanized areas." The delineation of these areas is now based on land use and the density pattern. Another classification problem arose in recent years as the result of a trend of annexation whereby a number of cities have brought into their legal boundaries a considerable amount of land which is not densely settled. To take the new situation into account, the Bureau of the Census has recognized what it calls "extended cities" and within them has designated certain lightly settled sections as "rural under special rule." This has been done in 59 cities.

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[1] G.A. Brown, "Census Projections 1970-1985," Management Accounting, (January 1973), p. 12.

There are several factors that have led to the expanded utilization of land area in suburban rings. First, cars and trucks, new highways, electric power, and the telephone have all allowed people to move farther and farther away from the central cities without inconvenience including, in many cases, any major barrier to commuting. A U.S. Bureau of the Census study has found that only about one-fifth of all commuters spend more than a half-hour getting to work.[1]

Second, the number of households has been increasing more rapidly than the number of people. Between 1960 and 1970, our population increased by 11 percent while the number of households increased approximately 17 percent and the number of "primary individuals" (household heads with no relatives in the household) increased by almost 50 percent, indicating a greater tendency on the part of both young and old to live apart from their families.[2]

Over the next two decades, households will be formed by the children born during the 1950's and early 1960's, when fertility rates were high. The Rockefeller Task Force on Land Use has estimated that from now until 1985, over 27,000 new households are anticipated every week, equal to a city the size of Kalamazoo. The expected rate of increase between 1970 and 1980 is one-third greater than the actual rate between 1960 and 1970. Since each new household requires a place to live, the rate of household formation relates directly to the demand for housing and supporting facilities. Most of the demand for new housing over the next 20 years is likely to be concentrated in the outer portions of existing metropolitan areas, particularly the larger ones.

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[1] William K. Reilly (ed), The Use of Land: A Citizen's Policy Guide to Urban Growth, (New York: Thomas Y. Crowell Co., 1973), p. 79.

[2] Primary family. - A primary family refers to the head of a household and all other persons in the household related to the head by blood, marriage, or adoption. In the case of the primary family, the household head and the family head are the same person.

Primary Individual. - If the household head does not have any relatives in his household, then the head himself constitutes a primary individual. A household contains either a primary family or a primary individual. The number of primary families and individuals is identical with the number of households. (U.S. Bureau of Census. Definitions to Accompany the 1970 Census.)

The third factor contributing to the expansion of urban land area is our increasing affluence. The Commission on Population Growth and the American Future estimated that, by the year 2000, average family income will rise from the current $12,000 to more than $21,000 (in constant dollars) and that per capita consumption expenditures will more than double:

> Higher incomes mean higher levels of consumption--automobile ownership, recreation, travel, and the purchase of bigger homes and even second homes. With affluence, people demand more services - airports, power plants, shopping centers, freeways, public parks. As a result, the amount of land in urban use has been increasing at a far faster rate than the size of the urban population or even the number of urban households.[1]

Two other factors that have helped to re-enforce the process are zoning regulations and consumer preferences for single-family, detached homes. Illustrative of the former point, a study, by the Open Space Institute found that 95 percent of the vacant land in Greater New York is zoned for single-family housing.[2] With regard to the latter point a recent Gallup poll found, based on a 10 percent sampling of the population, that approximately 75 percent of the people preferred to live in single-family detached housing.[3]

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[1] William Reilly, op. cit., p. 79.

[2] Open Space Institute. Stewardship (New York, 1970), p.9.

[3] Statement by George Gallup, Jr. given before the National Conference On Managed Growth. (Chicago) September 16, 1973.

In summary, our population is becoming increasingly concentrated in existing metropolitan areas. Growth in household formation, transportation links, and affluence, however, have led to the expansion of urbanized land areas with a corresponding decrease in population density. If this trend continues, competition among conflicting land uses may be expected to increase. These potential conflicts and their environmental implications are discussed in the sections that follow.

2. Development Trends

The concentration of population in metropolitan areas and the ever expanding boundaries of the urban areas has - more often than not - been a haphazard process. The term "urban sprawl" has been coined to depict the uncontrolled nature of the growth. This section of the report will address the different types of both planned and unplanned development growth and their related effect on environmental quality. In addition some of the mechanisms which have helped to stimulate or re-enforce particular growth patterns are discussed in terms of their present and future influence. These mechanisms include transportation systems, sewer systems and wastewater treatment facilities, new towns, and traffic inducing facilities such as regional shopping centers, recreational and sports complexes, airports and large-scale commercial and industrial developments.

In recent years there have been numerous theoretical discussions and practical efforts to implement the concepts of no growth, limited growth, or managed growth. Most of these attempts have arisen in response to urban sprawl and uncontrolled land speculation and subdivision.

The results have taken the form of new restrictive laws, zoning actions, moratoria on building permits, density limitations, size or height limitations, bans on septic tanks, and so forth. While such actions have reached the headlines, there is very little evidence that the next step has been taken in terms of providing sound alternatives to future growth.

The just-released report by the Task Force on Land Use and Urban Growth, headed by Lawrence S. Rockefeller arrives at the conclusion that absolute "no growth" is not a viable option in the near future. "Population will grow. People will improve their status and seek more desirable living areas. A policy that would discriminate on individual freedom of mobility would be both legally and morally wrong."[1]

If growth is to be accommodated, the question may be raised as to what type of development pattern would best fit our needs while minimizing potential adverse environmental impacts. There are several forms which development can take:

a. Containment and intensification of existing urban areas;

b. Peripheral growth of existing urban areas (suburbanization);

c. New communities;

  (1) As satellites to existing major urban areas,

  (2) As independent entities substantially removed from existing urban areas,

d. Growth corridors.

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[1] Robert Cahn "Mr. Developer, someone is watching you," in Where Do We Go From Here?" (Christian Science Monitor, 1973), p. 4.

Earlier in this report the increasing concentration of our population in expanded urban areas was discussed. However, it was also pointed out that the process, if uncontrolled, would be a continuation of past trends in "urban sprawl". The process is described by Amos Hawley in Urban Society, An Ecological Approach: "Concentration at the point of convergence of local transportation lines develops a pressure which forces activites outward more or less symmetrically. Growth of the central business district pushes ahead of it a belt of obsolescence occupied by light industries, warehouses, and slums. This transition zone, in turn, encroaches upon a zone of low income housing, causing the latter to shift outward and to invade a belt of middle income residential properties. The latter finally spills over into suburban territory and presses against a zone of high income housing. The occupants of each zone tend to succeed to the space occupied by those of the next outer zone. At any moment in time, therefore, the distribution of land use exhibits a ring-like appearance."[1]

If this is the pattern of the Seventies, the trend for the future is seen by some as further population expansion away from the metropolitan centers which creates new demands for goods and services. In response to this is the rapid growth of "shopping center" development on the urban fringe forming the nuclei for "mini-cities."[2]

What are the environmental consequences of the dispersion of population? Is it more or less desirable than concentration? Advocates can be found to argue both sides of the question. The two sub-issues examined under this heading are designed to shed light on some considerations, albeit unresolved, that will be relevant to EPA policies and positions vis-a-vis the impact of population distribution on environmental quality.

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[1] M. J. Redding and B. T. Parry, "Land Use: A Vital Link to Environmental Quality." in V. Curtis (ed.) Land Use and the Environment. (EPA, 1973), p. 35.

[2] Idem .

The first sub-issue to be examined is the relationship between population density and environmental quality. Exhibit II shows average percentages of land use within different size classes of cities. One of the interesting facts revealed by this chart is the substantial amount of vacant land found in all cities. There are a number of planners, government officials and land use authorities who feel that this vacant land should be used in part as a base for new development that would help revitalize the inner cities. They point to increased expansion of urban areas as having both adverse socioeconomic impacts (loss of the inner city's economic base and the growth of slums) and unfavorable environmental consequences (greater dependency on automobile travel, the proliferation of regional shopping centers, increased costs for sewage collection and treatment, etc.). Indeed, there is some preliminary evidence that in terms of housing an equivalent number of people, the pollution generated by high-rise apartments is substantially less than for single family dwellings (see Exhibit III).

On the other side of the debate are those who feel that more intensive development in inner cities has its own set of socioeconomic problems (reflected in increased crime and mental health problems due to overcrowding) and environmental hazards (due to existing high levels of pollution, each increment to air and noise pollution - however slight - will be more hazardous to human health and welfare than increases in less polluted areas).

Exhibit II

Mean Percentage of Land Use in Selected Cities by Size

Land Use	Population of City Under 50,000	 50,000-100,000	 100,000-250,000	 More than 250,000
Number of Cities Studied	28	13	7	5
Mean percentage in following uses:				
Residential, 1 family	34.0	31.0	36.0	28.0
Residential, 2 families	3.7	4.1	3.6	6.8
Residential, 3 or more families	1.7	2.1	2.2	4.9
Commercial	3.1	2.6	2.9	4.3
Light industry	2.8	2.1	2.4	3.8
Heavy industry	2.9	2.7	3.5	4.7
Railways	5.0	4.9	5.4	4.4
Parks, Playgrounds	5.1	6.5	5.7	8.6
Public & Semipublic	13.3	10.9	11.2	9.6
Streets	28.3	33.3	27.6	24.8
Vacant	47.0	38.9	21.9	20.4

Source: Harland Bartholomew & Jack Wood. Land Use in American Cities. (Harvard Planning Studies. Volume XV, 1955), Tables 1, 2, 3, 4.

Out of efforts to find successful compromises to these extreme positions have come the concepts of "cluster" or "planned unit" development. These concepts involve improving the environmental quality and other amenities within high-density developments (see Exhibit III). Although the two terms are often used interchangeably, planned unit development (PUD) provides for a mix of varying residential densities, shopping and public facilities under a unified plan. Cluster development, on the other hand, is a way of subdivision design which builds recreational open space into a given units-per-acre equation and is often incorporated into PUD designs.

Exhibit IV shows that a given number of housing units and commercial and industrial activities can be built on a smaller acreage through cluster planning than is possible in most cases of urban sprawl. Because of this characteristic, on a given land area cluster planning permits greater open space than conventional subdivision, as shown in Exhibit V. This exhibit also shows that cluster development requires fewer linear feet of streets and sewer lines than conventional subdivision to serve an equal number of lots. This characteristic is important to EPA since fewer streets can reduce the potential levels of run-off from impervious surfaces, while reduced sewer lineage corresponds to a measurable capital savings by a factor of approximately 2.2.

Exhibit III

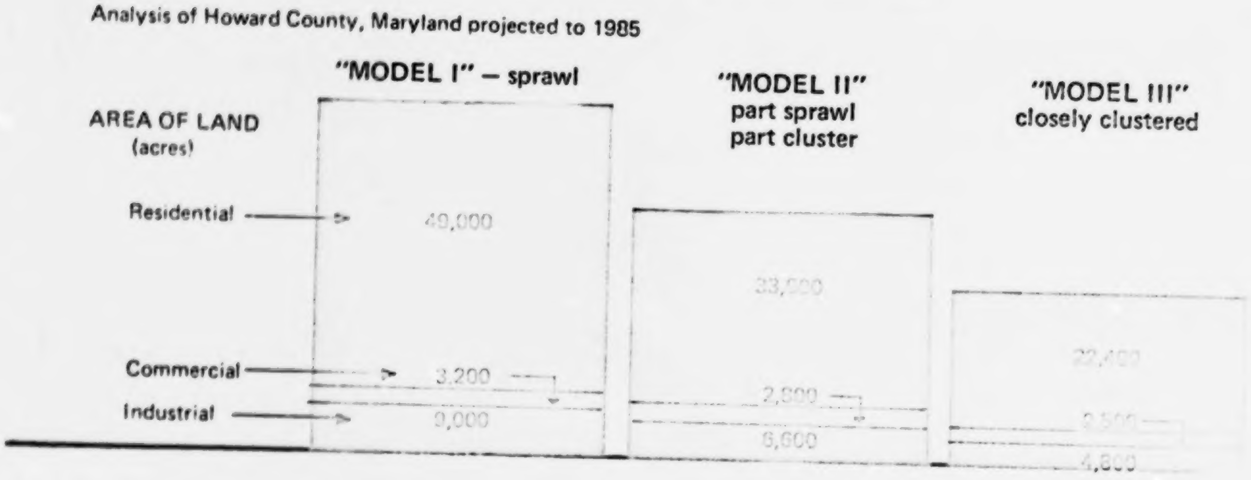
ENVIRONMENTAL EFFECTS OF ALTERNATIVE HOUSING PATTERNS

	Housing Pattern										
	A		B		C		D		E	F	
	Single-Family Conventional		Single-Family Clustered		Townhouse Clustered		Walk-Up Apartment		High-Rise Apartment	Housing Mix (20 Percent Each A - E)	
Number of Acres	500	100	400	100	300	100	200	100	100	300	100
Number of Dwelling Units	1,000	200	1,000	250	1,000	333	1,000	500	1,000	1,000	333
Environmental Effects											
Air Pollution (pounds per day from residential heating)											
Particulates	10.50	2.16	10.80	2.70	9.00	3.00	6.30	3.15	4.65	8.32	2.77
SO_x	.36	.07	.36	.09	.30	.10	.21	.10	.16	.28	.09
CO	.24	.04	.24	.06	.20	.05	.14	.07	.10	.18	.06
HC	24.00	4.50	24.00	6.00	20.00	6.67	14.00	7.00	10.00	15.40	6.13
NO_x	72.00	14.40	72.00	18.00	60.00	20.00	42.00	21.00	31.20	55.44	15.48
Water Pollution (kilograms per year from storm water runoff)											
BOD	19,052.4	3,816.5	14,132.1	3,533.0	10,696.9	3,566.3	7,904.4	3,952.2	3,992.1	11,095.1	3,699.4
COD	51,596.1	10,319.0	35,211.4	9,552.9	28,926.4	9,642.8	21,372.5	10,686.3	10,794.2	30,007.8	10,002.6
N	2,211.3	442.2	1,637.6	409.4	1,239.8	413.3	915.0	458.0	462.6	1,296.1	425.7
P	655.2	131.0	485.2	121.3	367.3	122.4	271.4	135.7	137.1	381.1	127.0
Suspended Solids	815,896.1	163,797.2	606,529.4	152,632.4	459,190.5	153,060.2	339,235.3	169,622.7	171,330.0	476,324.1	158,771.4
FCB (number x 10^{-6})	995,557.0	199,177.4	737,539.0	184,354.8	558,363.0	186,121.0	412,522.0	206,261.1	208,344.0	579,197.0	193,065.7

Note: For housing patterns A, B, C, D, and F, the left hand column shows the costs and environmental effects associated with 1,000 housing units placed on sites of different sizes, the right hand column shows a variable number of dwelling units on a constant site size of 100 acres. Type E contains both 1,000 units and 100 acres.

Source: Real Estate Research Corporation.

Exhibit IV
Land Consumption: Conventional Versus Cluster



Source: New York State Department of Environmental Conservation, Environmental Plan for New York State (Preliminary Edition, 1973), p. 20

The cluster and PUD concepts may be used to accommodate growth within a metropolitan area by channeling development into finger, multi-town, or a satellite cities pattern. Although much remains to be learned concerning the environmental effects of these alternative land use patterns, preliminary findings do provide some insight. For example:

> In Chicago, the air pollution implications of three alternative metropolitan plans were analyzed on the basis of emission estimates for two pollutants: oxides of nitrogen emissions and suspended particulate emissions from certain industry groups. The alternative plans investigated consisted of a Finger Plan (high-density corridors), a Multi-Town Plan, and a Satellite Cities Plan. For these two pollutants, it was found that the Finger Plan and Satellite Cities Plan were equivalent with respect to particulates, and both were about 30 percent lower than the Multi-Town Plan; the Finger Plan, however, produced fewer oxides of nitrogen than the other two plans.

> On the basis of these tests, it was concluded that the Finger Plan was the best alternative for air quality. Although this plan had fairly high residential and industrial concentrations, it also provided dilution potential for pollutants. This was true because the development corridors were elongated and bordered on either side by large green areas. Thus, the presence of green areas adjacent to pollutant sources is an important land use factor in pollution reduction. In both cases, the land use option providing the greatest opportunity for pollutant dispersion over green areas resulted in lower apparent pollutant concentration.[1]

There is some evidence that higher density development is a growing trend (despite the Gallup poll findings that the majority of people prefer single-family detached dwellings). Multi-family residences comprise about a half of the units, including mobile homes, built in the United States today. Back in the late Fifties, they accounted for only one-fifth.[2] New state laws facilitating condominium ownership have greatly enhanced the marketability of apartments. Although higher densities can be achieved in existing urban areas, the availability of land becomes the strong determinant vis-a-vis whether planned unit and cluster development efforts can be economically initiated.[3] In addition, the availability of land, together with other factors (topography, the presence of water bodies or other physical barriers, transportation networks and so forth), is also important in determining whether a finger, multi-city, or satellite city pattern can be adopted in a particular metropolitan region.

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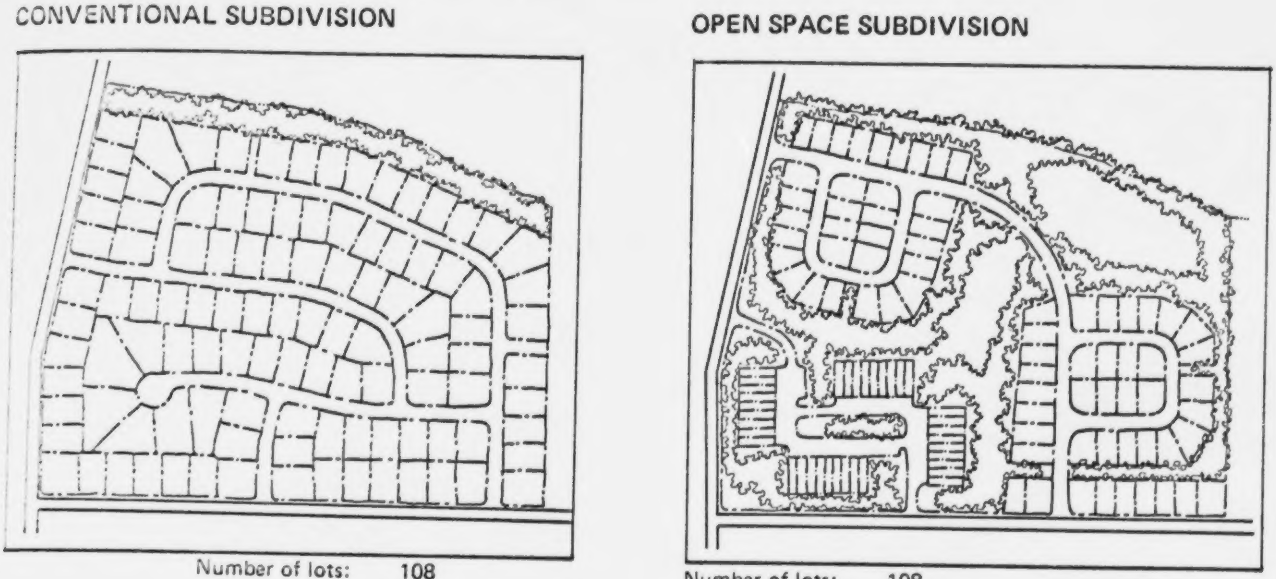
[1] Northeastern Illinois. Planning Commission. Managing the Air Resource in Northeastern Illinois (Technical Report No. 6 August 1967.)

[2] Edmund Faltermayer. "We're Building a New Kind of Togetherness" Fortune, (October, 1973), p. 131.

[3] Additional information on this topic is presented in the "Residential" study paper, presented in Appendix D.

Exhibit V

LAND USE: CONVENTIONAL VERSUS OPEN SPACE SUBDIVISION



CONVENTIONAL SUBDIVISION

Number of lots: 108
Open space: 10%
Linear feet of streets 5,400
Linear feet of sewer lines 5,400

OPEN SPACE SUBDIVISION

Number of lots: 108
Open space: 50%
Linear feet of streets 4,900
Linear feet of sewer lines 3,900

Source: New York State Department of Environmental Conservation. Environmental Plan (1973)

The second sub-issue of concentration versus development is closely related to the first. This question is concerned with the nature and magnitude of the impact of a particular development pattern on other types of land use. For example, if containment and intensification of existing urban areas become implicitly part of public policy, what will be the impact on existing rural land use? Will demand for recreation close to the urban centers force agricultural and other rural activities into new areas? Will it serve to reinforce trends for large property ownership patterns in rural areas, thereby indirectly encouraging monoculture, clearcutting and other practices which are suitable to large area management, but which have a high potential for adverse environmental impact? Several of these questions are taken up under the "Rural-Urban Interface" portion of this report. In general, however, many of the questions related to the potential land use and environmental impacts of different growth patterns deserve further research and analysis, together with the completion of certain EPA-sponsored studies now underway.[1]

3. Transportation and Wastewater Treatment

Two elements which have received a great deal of attention in terms of their ability to induce a dispersed population pattern are highways and wastewater systems. Although the location of highways and wastewater treatment facilities are dealt with in the siting portion of this report (see Part III), some of their implications vis-a-vis population distribution are most appropriately raised at this point.

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[1] For example, the University of Chicago is conducting a study which has as its goals the following:

1. Identify land use forms that naturally generate the least pollution.
2. Investigate national trends in population distribution and land use so that some expectations can be developed as to the likely impact on pollution.
3. Evaluate and analyze alternate proposals for urban development.

Based in part on the findings of the University of Chicago study, an investigation will be carried out by the Center for Urban Development Research of Cornell University for the purpose of:

1. Identify the changes in pollution resulting from incremental business and residential land use.
2. Prepare a method to analyze the trade offs involved.
3. Describe the long range forecasting implications to urban form and land use.

a. Transportation

There are substantial bodies of evidence and numerous case studies that support the pervasive and often large-scale impact of highways on the use of surrounding land. A prime example is provided by the experience of Parsippany-Troy Hills, New Jersey, which is in the process of becoming a regional cross-roads with the completion of five highways in the vicinity of the town. Even while construction of the road network was still in progress, the total value of commercial and industrial property in town rose over one decade from $14 million to $86 million, while the value of all property increased from $107 million in 1960 to $483 million in 1970.[1] Another example can be seen in the impact of highway development in Appalachia. Between 1962 and 1969, 1,149 new plants were built in the Appalachian region. Of these 75 percent were built within 30 minutes of a newly finished development highway.[2] For other illustrations one need only check the annual Real Estate Investment Handbook or the monthly publications of the National Real Estate Investor or Industrial Development for listing upon listing of jumps in land prices and increases in the number of development projects being constructed in proximity to new highways.

As evidence that highways have an impact on growth, a number of studies have found that new highways rather than reducing congestion by diverting traffic from existing overcrowded roadways, generate substantial amounts of new traffic movement:

> Highways are often obsolete by the time they are completed since free expressways generate up to 60% new traffic and toll roads attract 30% additional vehicles. Express high-

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[1] New York Times, August 19, 1971, p. 26.

[2] U.S. Senate hearings before the Subcommittee on Roads of the Committee on Public Works. Federal Highways Act of 1970 (91st Congress, Second Session, July 14-20, 1970), Part 2, p. 617.

ways designed to reach maximum levels of use in 1985 frequently exceed goals set for them within two or three years after they were put into use.[1]

The future impact of highways on population distribution is generally projected to be strongest in suburban areas. There are basically three reasons behind this trend:

(1) The Interstate Highway System was 98.7 percent complete by November, 1973 and is expected to play a relatively minor role, compared to its past impact, vis-a-vis inducing population dispersion.[2]

(2) Several large cities have been holding up any further highway construction, pending further evaluation of public transit alternatives and the release of new sources of funds for transit investment and operations.

(3) Finally - and perhaps most importantly - the Federal Highways Administration (FHWA) construction program calls for a strong emphasis on suburban areas (see Appendix C entitled, "Highways").

Historically, highways in suburban areas have had a greater development impetus than in other areas. One study has found that "highway access seems to help growth and retard population losses, the closer the community is to the metropolitan area".[3]

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[1] National Commission on Urban Problems. Fragmentation in Land-Use Planning and Control (Report No. 18, 1969), p. 23. The impact of intersections on induced growth is treated under the "indirect sources" heading to this section.

[2] In 1971, of the total designated system mileage of 42,500, a recorded 32,988 miles were opened to traffic, 7,960 miles were under construction, and 1,552 miles had not been started.

[3] Nevertheless, the report goes on the say that highways are not a significant factor where communities are either gaining or losing population.
Rivkin/Carson Inc., Water Resources Policy & Population Change, (Washington, D.C. 1971), p. 13.

Consequently, the impact of highways in suburban areas will continue to play a strong role due to the focus of the FHWA construction program. Furthermore, although most localities place a high priority on ensuring the mobility of their inhabitants, they cannot consider public transit as a viable economic alternative in achieving this goal because public transit systems to be efficient require a certain density within their service area. Before the advent of the automobile age rail rapid transit generally evolved where there was a city population of around one million persons, at population densities in excess of 15,000 persons per square mile, with a strong central business district and a land-use pattern oriented toward that center. Since the automobile has come into widespread use, "threshold" populations for rail rapid transit in U.S. cities generally appear to be in excess of 30,000 persons per square mile.[1] Even bus service needs estimated densities of 5 to 10 families an acre to be practical.[2]

Some people have suggested that new systems such as "dial-a-ride" and "personal rapid transit" may hold a partial solution to providing public transit in areas of lower densities. Others have advocated policies such as reverse migration back into the metropolitan centers as a means of achieving the critical density levels. This latter suggestion, however, deserves closer scrutiny with respect to the tendency of public transit systems to have their own impact in re-enforcing trends towards concentration. For example, in Toronto during the 10-year period from 1952 to 1962 more than

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[1] Wilbur Smith and Associates. The Potential for Bus Rapid Transit 1970, p. 26.

[2] New York Times. August 19, 1971, p. 26

50 percent of the high-rise apartment construction projects were located on the new subway line, while approximately 90 percent (5.1 million square feet) of all office construction in Toronto during the same period took place along the rapid transit corridor.[1] Similarly, since BART was approved by the voters in 1962, office space in San Francisco increased by 78 percent and all the new buildings are within five minutes of a BART station.[2]

Other examples of this kind of impact can be cited for New York City, Cleveland, Boston, Chicago, and Philadelphia. Increased use of public transit may also have an indirect impact on land use within inner cities by requiring that less land be set aside for parking facilities.

It should be pointed out, nevertheless, that in spite of the tendency in this hemisphere for public transit to concentrate development, this does not always have to be the case. In Stockholm, for instance, the response to increasing densities and congestion in the central city was to decentralize and use the rapid transit system to establish satellite towns linked to the downtown area. There are presently 18 satellite towns housing from 10,000 to 50,000 people. By the planned introduction of rapid transit links, the metropolitan area of Stockholm has managed to more than double its size without many of the problems of rapid growth.[1]

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[1] G. Warren Heenan, "The Economic Effect of Rapid Transit on Real Estate Development, The Appraisal Journal (April, 1968), p. 26.

[2] Terrell W. Hill, "The Impact of Transit on The Central Business District," Transportation Lifeline of an Urban Society, (Pittsburgh Urban Transit Council, 1969) p. 140 f.f. **BART - Bay Area Rapid Transit**

In terms of air quality increased use of public transit offers a tremendous advantage over automobiles. Exhibit VI compares emissions from automobiles with 1976 pollution control devices to the present day emissions from the Metroliner operations. **The results show from 10-18 percent difference between the auto and rail modes, based on total pounds of emissions per thousand seat-miles.**

Exhibit VI

REPRESENTATIVE TRANSPORTATION EMISSIONS*

MODE	SPEED (MPH)	UHC	CO	NOx	SOx	PART.
AUTO (1976)	60	.27	2.21	.26	-	-
METROLINER	125	-	-	.22/.11**	.08/.04**	.01/.006**
	160	-	-	.33/.17**	.12/.06**	.02/.01**
AIR (DC-9-30)	565	.56	.73	.30	.13	.052

* Expressed in Units of Lbs. Per Thousand **seat-miles.**

** These figures showing emissions from the electric generating plan providing the motive power reflect a range from highly-controlled fossil fuel with 1% fuel, 50% coal, and 50% oil (on the left), to 50% nuclear and 50% highly-controlled fossil fuel (on the right).

Source: Strategic Planning Division, Office of Systems Analysis & Information, Assistant Secretary for Policy & International Affairs, Department of Transportation, 1972.

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[1] Parsons, Brunckerhoff, Tudor, Bechtel, Sverdrup & Parcel, St. Louis Metropolitan Area: Rapid Transit Feasibility Study (PB 204-060, St. Louis, August, 1971), p. 76.

Public transit can also play an important role in energy conservation. In 1970, transportation consumed 16.4 quadrillion BTU's (approximately 25 percent of the total energy used in the country).[1] Automobiles consumed more than 55 percent of the transportation energy in 1970, while trucks, the second largest users consumed about 21 percent of the total. Examination of the passenger or ton miles per gallon of fuel of various transportation modes yields significant trends and patterns with respect to relative energy efficiency. Of the energy consumed by automobiles, 55 percent is consumed within urban areas and 30 percent is consumed in making trips of 10 miles or less. Yet the energy efficiency for automobiles in urban use is 7 passenger miles per gallon of gasoline or energy equivalent, compared to 40 for urban buses and 120 for commuter trains.[2] Steady increases in power and speed have caused the energy-efficiency of automobiles to decline over the years. The decrease in energy efficiency due to mandatory pollution control devices, although not entirely certain as yet, is expected to continue for larger vehicles. Smaller vehicles are expected to achieve greater energy savings with controls in the coming years.

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[1] British thermal unit or the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2°F.

[2] Northeast Corridor Transportation Project. NECTP Final Report, (Prepared for U.S. Dept. of Transportation), Vol. 3, p. C-7.

For public transit to have a significant impact on air quality and energy conservation, it must divert riders from automobiles, rather than merely provide mobility for people previously limited in this respect (i.e., the poor, elderly, young, and handicapped). Approximately two-thirds of the nation's entire highway system has been financed under federal-aid programs and this proportion will probably continue in the future.[1] Consequently, it may be of significance if EPA in its advisory role to the Federal Highway Administration were to advocate that proposed routeway alternatives be evaluated not only in terms of potential environmental impacts but also in terms of establishing express bus lanes, the provision of parking and easy access to public transit systems, and maximizing diversion from congested streets and highways rather then generating new traffic with all its implications for speculative, unplanned growth.

Since many states are developing air quality control plans which hinge on increased use of public transit, facilitating this effort also becomes an issue of some concern to EPA. At the time of this writing EPA estimates that 12 to 18 cities require augmented mass transit systems to achieve air quality standards. Nevertheless, many localities are still poorly served by public transportation systems. In determining the success and failure availability of transit in such areas, the proposal in the President's recent State of The Union message (January 31, 1974) to increase by nearly 50 percent Federal assistance to urban transit is most significant. Another important development was the enactment in November 1973 of PL93-83. This act provides for the eventual use of Highway Trust Fund revenues to finance mass transit construction projects. The potential impact of this financial source of support for transit can be seen from a few pertinent figures. The Highway Trust Fund during only the three month period ending September 30, 1973, received \$1.7 billion of tax revenue income and disbursed \$1.1 billion.[1] In contrast, it has been estimated that the plans for providing an improved high speed rail system along the northeast corridor could be implemented with a capital investment of from \$600 million to \$800 million.[2] A totally new fixed rail rapid transit system such as the Bay Area Rapid Transit (BART), on the other hand, can cost slightly over \$1 billion, while a number of express bus systems have been set up for less than \$100,000 each.

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[1] Motor Vehicle Manufacturers Association of the U.S., Inc. 1971 Transportation Facts. Detroit, 1972, p. 51.

With regard to assisting existing systems and helping maintain newly established systems, there have been numerous arguments that federal policy in the form of direct and indirect subsidies to other modes of transportation have had a strong negative impact on the economic status of transit systems. The Administration is presently working on a program entitled the Unified Transportation Assistance Program (UTAP) which will provide some measure of operating assistance for transit systems. A Congressional bill has also been introduced to authorize mass transit subsidies. Although the future of these programs remains to be determined, it may be desirable for EPA to review the proposals in terms of giving possible support.

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1. Journal of Commerce. November 26, 1973, p. 3

2. Harbridge House, Inc. Improved High Speed Rail for the Northeast Corridor. Prepared for the Federal Railroad Administration (December 15, 1972), p. A-34.

b. Wastewater Treatment Facilities

There is much controversy at the present time over the role of wastewater treatment facilities in inducing growth or serving as a prime determinent channeling the direction of growth. For example one study, based on the examination of a large body of literature, concluded that:

- The increased attractiveness of sewered areas encourages land speculation and increased real estate values. Although it is difficult to isolate sewer-related increases, a doubling in value seems common, while three, four, and five-fold increases in value are not exceptional.
- Sewer-inspired development is often of the dispersed sprawl type with deleterious effects on available level of public services to residents of the newly developed areas, on per capita public services in the region a a whole, and/or on tax burdens to residents of other areas in the region.[1]

In contrast another study charged with examining the potential role of water policy in shaping the population distribution pattern of the United States found that:

> ...water policy, if defined in quite specific terms, can have an effect on the manner in which urban settlement is created. While the impact of water policy on where population and economic activity locates may be minor indeed, such policy can influence how urban development is to take place and at what standards of efficiency, environmental quality and amenity. The positive impacts of water and allied facilities and services on the settlement pattern can best be achieved by joint effort with other Federal activities directed to the same places at the same times and buttressed by appropriate actions on the State and local levels. The essential rule for success is to avoid treating water independently from the development of other resources.[2]

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[1] Environmental Impact Center. Secondary Impacts of Federal Infrastructure Environments. Prepared for the Council on Environ-Quality. July 1973, p. 6.

[2] Rivkin/Carson, Inc. Water Resources Policy Population Change. Prepared for National Water Commission (Oct. 1971) p. IV. It should be noted that there are different institutional contexts within which these 2 conclusions were formulated. The first example deals specifically with a case of water pollution abatement where pollution control problems already exist. In such a case water is treated as a scarce resource, if not in terms of availability then of quality. The second example focuses on water policy per se which deals with the use of water over broad areas such as river basins which may have a combination of relatively clean areas as well as sources of pollution.

The conflict between these two quotations raises a number of issues for EPA in terms of its mandated responsibility to oversee the municipal wastewater treatment permits program. For example, what are the factors that magnify the importance of the effect wastewater systems have on the nature and direction of growth? Do the relatively low capital and operating costs for sewage collection and treatment as a proportion of total community infrastructure costs make it easier for this type of investment decision to be reached by localities? To what extent is it true, at the present time, that the existence or feasibility of sewerage and water treatment has been the principal factor leading to decisions on whether an area should be rezoned for development or whether a subdivision should be permitted? To what extent does the financing of systems through the levying of user charges, connection fees, and other taxes result in enlarging the service area as a means of increasing revenue, rather than as a response to existing needs?

If sewer systems act in fact as growth inducers, the implications are important to EPA policy. Indeed, EPA programs emphasizing regional system - in order to take advantage of certain economies of scale - may have indirect adverse impacts as some areas design larger systems to obtain EPA funding, without understanding their implications for growth.

Another question that deserves careful consideration is whether priority should be given to upgrading of wastewater treatment systems or building new ones. If old systems are not upgraded, degradation policies may be violated. If, on the other hand, upgrading old systems is given priority will this negate efforts for planned-unit and cluster developments and new towns? Will it create other problems such as those related to sludge disposal? Sludge disposal can be very difficult due to the lack of landfill in areas of heavy population concentration. The conversion of sludge to solid form for use as fertilizer or reclamation of strip-mined land may be a useful alternative in rural lands but probably not a feasible solution in urban areas due to odor problems and the need to use costly fuel resources for the conversion process, since land adequate for sun-drying may not be available.

If, on the other hand, the emphasis is placed on the construction of new systems or extending new interceptors, what will be the impact in erosion or flood-prone areas? Will planners be trading off sanitary sewage problems for large amounts of construction-related sedimentation? What will be the implications in terms of new construction extending the area covered by asphalt and concrete, with the consequent reduction of penetrable surfaces and increase in runoff?

Overall, in terms of urban versus suburban growth, there is evidence that sewer systems can have characteristics similar to highways in inducing growth and escalating the rate of development. The results of one study, for example, showed that a 20-year design capacity wastewater system is often consumed in half the time. In the previous section the alternative of public transit to offset some of the uncontrolled growth normally associated with highways was discussed. It is logical, therefore, to raise the question of whether water resource development can be an effective tool in directing settlement patterns:

> The logic of using water resource and allied investments along with other public works consciously to shape a settlement pattern has been frequently and persuasively argued. Unfortunately, there are few demonstrated examples where this logic has been applied. Efforts in individual new communities and planned unit subdivisions show definite promise at the small scale. At the larger, metropolitan scale the report discussed two attempts that can have wider significance. One, in the Raleigh-Durham-Chapel Hill region of North Carolina is a regional development guide which sets forth the availability of water supply and sewage treatment along with watershed protection, as the basic elements to shape the region's future settlement. Promulgated by a metropolitan agency which

> has review power over applications for Federal assistance, this plan has a possibility to become an effective tool. The second comes from Canada where the Metropolitan Toronto government tied the area's future land use plan to programs for metropolitan water and sewer development and other public works. Both of these examples provide concrete evidence of how water policies and programs, linked to land use controls, can attempt to determine private urban development decisions according to publicly desired patterns of growth.[1]

Even these efforts, however, seem to stress control of growth in the urban fringe. This is offset to some extent by the guidelines to Section 201 of the Federal Water Pollution Control Act which required the development and implementation of areawide waste treatment management plans that are tied to land use plans. Nevertheless, without both careful planning and a well conceived approach to land use control, a trend towards increasing suburbanization, for example, may be counter to the direction of implementation of the Clean Air Act standards in encouraging the concentration of population into center cities to reduce dependency on automobiles. Or, to look at the matter in reverse, the concentration of population to reduce pollution from mobile sources may lead to the overloading of existing sewage treatment facilities. In many ways this may seem to be an issue of intermedia conflict. Nevertheless, the conflict is often created because plans for new wastewater and transportation systems are based on trend forecasts, rather than being based on a well-conceived land use plan.

One further sub-issue of wastewater treatment facilities and their impact on suburban growth deserves consideration. This is the question of the use of septic tanks rather than wastewater systems to permit growth in outlying areas. If there is a trend towards increased use of septic tanks and cesspools, the argument may be made that in terms of effectiveness in land use control, EPA should focus greater attention on encouraging growth in areas with soils suitable for septic tanks. The question takes on particular significance with respect to the current boom in second home development.

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[1] Rivkin op. cit., p. XI.

Recent trends, however, show that there is much less dependence on septic tanks than ever before. A survey performed by the American Land Development Association found that of all the leisure home projects surveyed, only 28.8 percent in 1972 were designed to have access to sewer systems, while for 1973, developers estimated the proportion would be on the order of 42 percent.[1]

Since the trend (as expressed by industry spokesmen) is that developers are definitely moving in the direction of sewer access, it can be concluded that any action set by EPA either through its construction grants or its municipal permit program can have a relatively high degree of impact on growth. Specifically, prerequisites to funding of new construction of waste water treatment facilities include community land use planning and management. In the case of municipal permits, since design capacity is set forth in the permit and EPA can initiate a ban if violations occur (under Section 402-h), many municipal treatment managers will be likely to initiate planning activities on their own to accommodate the rate of growth and/or slow growth to avoid sanction. It will also be in the interest of private and public developers to see that such comprehensive planning is carried out and, therefore, they will probably contribute a degree of support that has not always been present in more traditional planning efforts.

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[1] Based on telephone conversation with Mr. Richard Ragety of the University of Oregon.

4. **Indirect Sources**

On October 26, 1973, EPA issued a set of proposed regulations concerned with state review of the air quality impact of constructing certain types of facilities that generate a substantial amount of traffic.[1]

In releasing the regulations, EPA Administrator Russell E. Train noted that they have an "extremely significant" potential to affect the course of development in the United States, since they will serve to "stimulate conscious public judgements about how land use resources will be used in the future." [2]

The reason for such a statement is that the types of development covered by the proposed indirect source regulations include but are not limited to shopping centers, sports stadiums, airports and highways, parking lots and garages, recreational centers and amusement parks, and commercial or industrial development. While indirect source reviews will address the issue of localized carbon monoxide concentration and will, therefore, be limited to consideration of facility design (with the exception of airports and large highways which will be reviewed for area-wide impacts), the impact of these facilities on patterns of growth will be significant as regards maintenance of air quality. Because such facilities have often been a force in strengthening and even inducing urban spread or suburbanization trends, it is appropriate to discuss them in conjunction with other concentration/dispersion issues rather than within the siting issues section.

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[1] Under the proposed regulations within SMSA's (areas with the potential for exceeding any national standard within the subsequent 10 year period) the facilities that are to be reviewed for impact include: New roads and highways expected to carry average daily traffic volume of 20,000 or more vehicles within 10 years of construction and modified roads expected to increase existing average daily traffic volume by 10,000 vehicles or more; new airports expected within 10 years to have 50,000 or more aircraft operations per year by regularly scheduled carriers, and any modified airports expected to increase scheduled operations by 50,000 per year; any facility which includes new parking area for 1,000 cars or more or modified parking increasing capacity by 500 cars or more. Outside SMSA's facilities that are to be reviewed for impact include: facilities having new parking capacity of 2,000 or more cars or modified capacity of 1,000 cars.

[2] "EPA Orders Air Quality Review of Future Large Developments", Land & Environment. (Vol. 1, No. 3) Nov. 2, 1973, p. 18.

Another reason for discussing indirect sources at this point rather than under the "siting issues" portion of the report is that the photochemical pollution occurring in the atmosphere is the result of auto exhaust emissions reacting in the presence of appropriate oxidants and atmospheric conditions. Consequently, the issue may often be not one of where a particular facility should be sited within an area as much as a question of should the facility be constructed at all. Specific types of indirect sources and their growth trends are discussed in the paragraphs that follow.

a. Shopping Center

A shopping center as defined by the Community Builders Council is a "group of commercial establishments, planned, developed, owned and managed as a unit related in location, size, and type of shops to the trade area that the unit serves; it provides on-site parking in definite relationship to the types and sizes of stores."[1] As the shopping center evolved, three types emerged, each distinctive in its own function: the Neighborhood, the Community, and the Regional Center. General characteristics distinguishing these three types are summarized in Exhibit VII.

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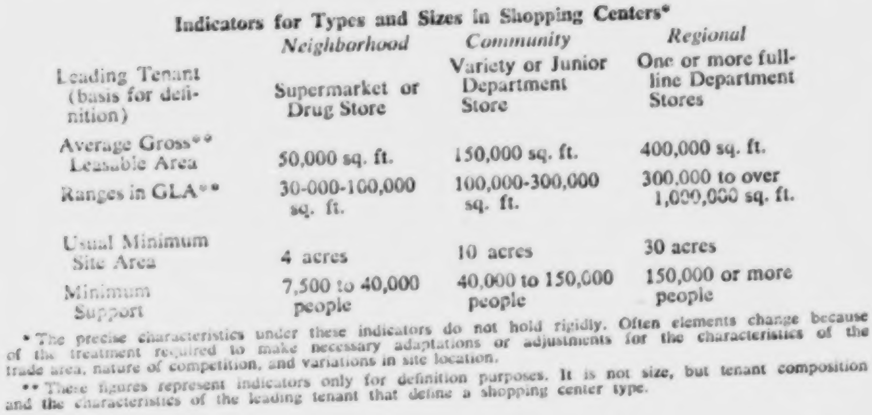
[1] Urban Land Institute. The Community, Builders Handbook (Washington, D.C. 1968), p. 264.

Exhibit VII



Indicators for Types and Sizes in Shopping Centers*

	Neighborhood	*Community*	*Regional*
Leading Tenant (basis for definition)	Supermarket or Drug Store	Variety or Junior Department Store	One or more full-line Department Stores
Average Gross** Leasable Area	50,000 sq. ft.	150,000 sq. ft.	400,000 sq. ft.
Ranges in GLA**	30-000-100,000 sq. ft.	100,000-300,000 sq. ft.	300,000 to over 1,000,000 sq. ft.
Usual Minimum Site Area	4 acres	10 acres	30 acres
Minimum Support	7,500 to 40,000 people	40,000 to 150,000 people	150,000 or more people

* The precise characteristics under these indicators do not hold rigidly. Often elements change because of the treatment required to make necessary adaptations or adjustments for the characteristics of the trade area, nature of competition, and variations in site location.

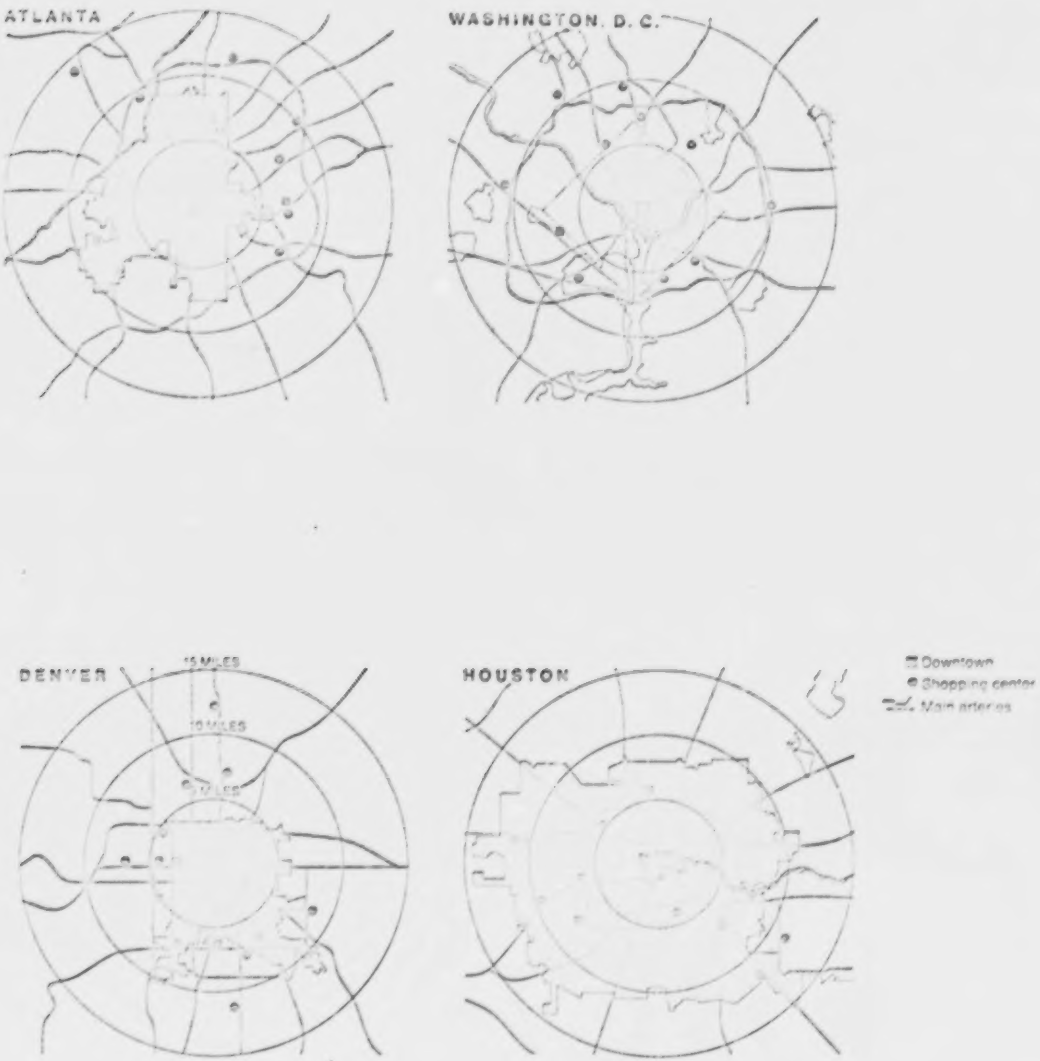
** These figures represent indicators only for definition purposes. It is not size, but tenant composition and the characteristics of the leading tenant that define a shopping center type.

Source: Urban Land Institute. The Community Builders Handbook (Washington, D.C. 1968), p. 267.

There are approximately 15,000 shopping centers scattered throughout the United States, although a large proportion of these are accounted for by neighborhood and smaller community types of facilities. It is the larger community centers and regional de-developments, on the other hand, that are critical in terms of indirect source regulation. The impact of the larger shopping centers is partially shown by the illustrations in Exhibit VIII. The exhibit shows how a mercantile ring around central business districts has been joined by large regional shopping centers in a growing number of metropolitan areas. Although the precise pattern varies, in each of the four cases, the location of the shopping centers depends on population concentrations and the configuration of the freeways, which enable shoppers to travel considerable distances in a short time. Collectively, the giant centers are not only pulling business from downtown but are giving big urban regions

EXHIBIT VIII

Siting Patterns of Shopping Centers for Selected SMSA's


ATLANTA
WASHINGTON, D. C.
DENVER
15 MILES
10 MILES
5 MILES
HOUSTON
Downtown
Shopping center
Main arteries

Source: Fortune, October, 1972, p. 82-83.

a fundamentally new structure. For example, the 66-mile Capital Beltway around Washington, D.C., completed in the mid-sixties, has become the real main street of the metropolis. Some 800,000 new inhabitants settled along the beltways' borders during the last decade and no less than 12 regional shopping centers now vie for their trade."[1]

In the past, the preference for suburban shopping center locations has tended to maximize the traffic inducing characteristics of these developments. The magnitude of traffic generated by shopping centers is partially revealed by parking space ratios.

The Urban Land Institute, for example, having conducted a major study on parking lot sizes found that in operational practice and hence for development planning purposes, where there is virtually no walk-in trade nor public transit usage, the provision of 5.5 car parking spaces per thousand square feet of gross leasable area is adequate as a standard to meet the demand for parking space at shopping centers for all but the 10 highest hours of demand during an entire year. (These 10 highest hours occur during the three peak days of the year.)[2]

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[1] "Downtown Has Fled to the Suburban Fortune, October 1972, p.p. 82-83.

[2] Urban Land Institute, op. cit. p. 342.

According to this ratio and actual figures for recently constructed centers, regional developments with 5,000 to 10,000 parking spaces are not uncommon.

Although, it can be expected that over the next 20 years a number of new regional centers will be constructed in suburban fringe areas, there is a countervailing trend that has come into evidence this past year. This trend is to build new regional centers within inner city areas. Recent developments in Los Angeles, New York City, Pittsburgh, Worcester, and Salt Lake City are just some examples of this change in direction. In some cases, such as the major center that just opened in Queens, New York, the development is integrated within the existing urban scene. In other cases the development may be integrated within an urban subcenter such as Century City in Los Angeles, Crystal City in Washington, D.C., and Colony Square in Atlanta.

The reasons for the shift in interest to downtown are numerous and somewhat overlapping. The president of one department store chain credits this new trend to a very subtle change in attitude that is taking place: "People are admitting that they miss the varied services of the city, and many of them really want to come back - to work and in some cases to live."[1] Another reason given is that retailers are finding that many suburban neighborhoods are heavily overloaded with stores. Consequently, if the retailers can locate within urban areas where redevelopment is already underway, they tend to feel that the resulting increased market potential makes it a better investment opportunity.

"Suburban Malls Go Downtown" Business Week, (Nov. 10, 1973), p.90.

One businessman has summarized the trend as follows:

> The new togetherness marks quite a change for a country that has had a 'throwaway attitude' toward cities and suburbs, tending to let the old deteriorate and to keep pushing outward. While some sprawl doubtless will go on, the prospect is for more coming together, and more urbanization of a tighter, clustered type. For businessmen, this brings forth a new opportunity, as well as some dangers. Because the new centripetal movement promises more redevelopment closer in, and more 'infilling' of bypassed tracts, land speculators operating far out in the exurbs may find themselves stuck with acres and acres of weeds.[1]

The environmental implications of this trend revolve around the amount of traffic (and associated air pollution) that shopping centers will generate in the future. The new Queens center, for example, is at a crossroads for numerous bus lines, a subway system and a major commuter roadway. In addition, a number of highrise apartment buildings are within walking distance. As a result, the facility offers underground parking for only 1,300 cars.

If the shopping center was built in a more remote location, its gross leasable area (according to the Urban Land Institute standard) would require parking space for almost 8,000 cars. Consequently, the trend towards downtown locations, especially in areas with good public transit systems, could reduce the importance of shopping centers as a major issue of EPA concern in the future.

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[1] Edmund Faltermayer, "We're Building a New Kind of Togetherness," Fortune, October, 1973, p. 240.

b. Sports Stadiums

As of March, 1973, seven new sport stadiums were under construction or in the planning stages. Close to 20 others have been constructed over the past decade. This rate of growth for new stadiums, however, is not expected to continue. For one reason the supply of sports teams, is not infinite, so that "an oversupply of stadiums is not inconceivable."[1]

Another reason is a matter of economics, since the majority of the facilities are only used for limited periods of time. Stadiums are not easily converted to alternate uses, with some limited exceptions such as concerts and public speaking forums. Finally, the burden of a financially unsuccessful stadium falls directly on the taxpayer - a source of increasingly vocal opposition.

Generally, the locations of sport stadiums are fairly evenly split between suburban and downtown sites. The new plans for suburban facilities show a strong interest in using the stadiums as a focal point for a multiplicity of development activities. For example, the proposed Meadowlands Stadium in New Jersey is the centerpiece of the state's 30-year plan to convert the tidal marsh that occupies the lower valley of the Hackensack River into a major urban center of plants, warehouses, office buildings, hotels, houses, apartments, parks, and open space.[1] In southern California, likewise, a proposed sports complex is to be the starting point for the eventual construction of a new town and major leisure home development.

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[1] "New Jersey's Stormy Land-Use Battle" Business Week (Dec. 9, 1972) p. 94.

Downtown stadiums do not have the same kind of induced growth impact as suburban facilities. Nevertheless, both types of complexes seem to generate similar levels of automobile traffic. In an analysis of the siting controversy over the Seattle's proposed King County Multipurpose Stadium, it was reported that while standard rules of thumb call for 10,000 or more parking spaces for a 65,000 seat stadium, Seattle's plans provide for only 2,500. Stadium officials count on existing downtown parking capacity to ease the demand. They also hope that many fans will travel to the stadium by bus, despite the fact that "other cities have found it next to impossible to separate sports fans from their automobiles."[1]

If indeed, sports fans continue to rely on private automobiles for access to stadiums (and both the validity of this observation and the reasons behind it deserve further study), a downtown location may have a more environmentally deleterious effect due to the emissions released by traffic under severely congested conditions. Nevertheless, the location and number of sports stadiums built is often a matter of political decision and/or community prestige and may, therefore, continue to present a continuing problem of greater concern than some other types of facilities falling under the proposed indirect source regulations.

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[1] Fortune, March 1973, p. 106.

c. Airports

In 1972 there were 12,070 civil airports of all kinds existing in the United States of which 3,240 were part of the National Airport System and 346 had Federal Aviation Administration (FAA) Air Traffic Control Towers. For the purpose of indirect source regulation EPA proposes for review all airports with 50,000 or more regularly scheduled aircraft operations. At present there are 44 airports with 50,000 or more commercial operations annually and 35 with 25,000 - 49,000 yearly commercial operations. The large majority of the airports in this latter category will probably exceed 50,000 operations over the next decade. The locations of these airports have been plotted on the map shown in Exhibit IX.

Airports create a variety of environmental problems related to the concentration of motor traffic and new commercial development. In the case of traffic, a survey of the airline passenger, employee, and visitor population at 10 airports found that passengers accounted for nearly one-half of the airport population, employees about one-fifth, and visitors better than one-third.[1]
The number of daily access trips made to and from the airport, however, is different than the reported airport population. It is estimated that the total number of daily ground access trips to and from the 10 airports referenced is nearly 50 percent greater than the populations cited. Viewed in this context, airline passengers account for only one quarter of the access trips, as do employees. Visitors account for one-half of them.[2]

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[1] Scott D. Thayer. Vehicle Behavior In and Around Complex Sources & Related Complex Source Characteristics. Sub-Task 2 - Airports. Prepared for U.S. EPA (No. EF-264, August, 31, 1973), pp. 18-19. Visitors include friends and relatives accompanying passengers, sightseers, and those on airport business (salesmen, service, and repair personnel). Employees include FAA flight controllers, airport staff, and representatives of consumer services such as restaurants, gift shops, rental car agencies, etc.

[2] Idem. The change in relative proportions is due to the fact airline transfer passengers are usually not involved in access to and from the airport. Further, each airline passenger accounts for a trip either to or from the airport whereas each employee and visitor accounts for a trip both to and from the airport.

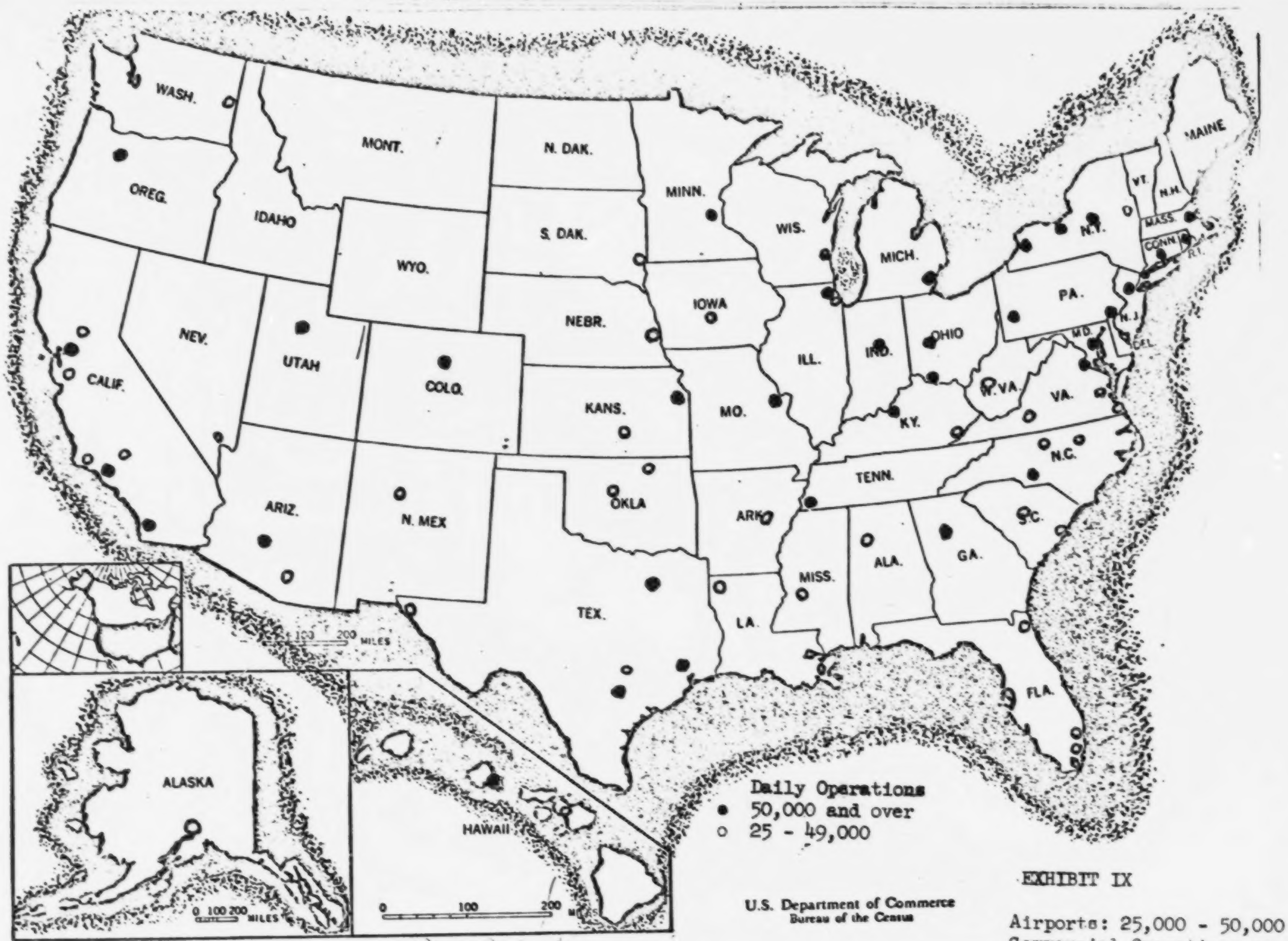
WASH.
OREG.
CALIF.
NEV.
IDAHO
MONT.
WYO.
UTAH
COLO.
ARIZ.
N. MEX
N. DAK.
S. DAK.
NEBR.
KANS.
OKLA
TEX.
MINN.
IOWA
MO.
ARK
LA.
WIS.
ILL.
MICH.
IND.
OHIO
KY.
TENN.
MISS.
ALA.
GA.
FLA.
S.C.
N.C.
VA.
W. VA.
PA.
N.Y.
MD.
DEL.
N.J.
CONN.
R.I.
MASS.
VT.
N.H.
MAINE
ALASKA
HAWAII
0 100 200 MILES
100 200 MILES
0 100 200 MI
Daily Operations
● 50,000 and over
○ 25 - 49,000
U.S. Department of Commerce
Bureau of the Census

EXHIBIT IX

Airports: 25,000 - 50,000 +
Commercial Operations per year

Source: Aviation Cost Allocation Study, Department of Transportation, 1972.

Despite the development of faster and more efficient airplanes, today's air travelers are increasingly forced to spend a greater portion of their total travel time on ground access to and from airports. For example, in a survey of 13 of the nation's largest airports, only three reported that they have no access problems at present.[1] Seven of the surveyed airports are looking to some sort of highway improvement to meet their access problems. Improvements cited include new links to freeways, reconstructed enroute freeway interchanges for more efficient traffic flow, or additional highwav capacity in terms of new or expanded facilities. The need for securing large tracts of land away from concentrated population areas for reasons of safety and noise places airports further and further away from center city locations, placing even greater dependence on highway access.

Recognizing the need to expedite ground transportation for air travelers, some of the nation's cities with major airports are attempting solutions of various kinds. However, provision of a direct and fast link between downtown and airport in order to bypass congested roads can often be a costly venture, and sometimes necessitates a less conventional mode such as monorail. If the service is designed to primarily benefit air passengers, however, the volume does not generate a large enough ridership to ensure economic viability, as is

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[1] Thayer, op cit, p. 20.. The airports surveyed included:

Atlanta Airport
Chicago-O'Hare International Airport
Denver-Stapleton International Airport
Kansas City Municipal Airport
Los Angeles International Airport
Miami International Airport
New York-Kennedy International Airport
New York-LaGuardia Airport
New York-Newark Airport
Phoenix-Sky Harbor Airport
San Diego International Airport
Seattle-Tacoma International Airport
Washington, D.C.-National Airport

the case with the monorail to the Tokyo airport. A more practical solution at the present time for meeting the ground access requirements for air passengers is possible, as has been successfully demonstrated by the Cleveland transit system. Since 1968, the Hopkins airport has been linked with the downtown area through a four-mile extension of the rapid transit system. At a headway of 10 to 12 minutes, the service transports airport-destined or originated passengers over the 12 mile distance between the central business district and the airport in 22 minutes, which compares favorably with the 30 minutes that is required by the auto during rush hours on the recently completed freeway.[1]

The extension was originally estimated to generate about 2,000 riders a day; instead it now serves as many as 4,000 riders a day. Of these riders, 57.6 percent are air passengers. Further, the extension resulted in the decline of three other modes of transportation-private automobile (8.2 percent decline), taxi (26 percent decline), and limousine (46.6 percent decline).[2]

Still, actual implementation of public transit-airport access proposals are far from imminent. Despite many years of planning, for example, New York City still has no subway link-up and only limited bus access to its airports. The future potential for providing transit access to airports is also somewhat doubtful for two reasons. First, an investigation of airport siting issues (see study in Appendix C) has revealed that, especially in the near-term, the trend will be away from constructing major new hub airports in favor of upgrading general aviation airports to divert some of the commercial flights away from congested facilities. The geographic spread and smaller size of these reliever airports will preclude the possibility of public transit service. Second, as airport hub sites are selected in areas more and more remote from centers of population (e.g. the proposed Stewart airport site 65 miles north of New York City) automobile traffic will inevitably increase.

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[1] Nancy Sheldon & Robert Brandwein. The Economic & Social Impact of Investments in Public Transit. (Lexington, Massachusetts: D.C. Heath & Co., 1973), p. 36.

[2] Cuyahoga County, Regional Planning Commission. Cleveland Hopkins Airport Access Study. Prepared for U.S. Dept. of Transportation (June, 1970) p. V.

In addition to the motor vehicular traffic generated, airports can serve as a force in attracting new development which, in turn, creates even more demand for automobile travel. Among the activities attracted are commercial enterprises (hotels, motels, restaurants, and office complexes), industrial developments (primarily industries producing high value, relatively light-weight goods and/or those requiring fast transport to reduce inventory requirements), and residential complexes to meet labor needs of the airport and other attracted activities. As an illustration, satellite industries attracted to San Francisco International have been estimated to account for 90,000 jobs. Similarly, in anticipation of the openings of the Dallas-Fort Worth airport, 130 zoned industrial district/parks have located within 30 miles of the new facility.

Growth around new hub airports is amenable to certain types of control such as through the use of buffer zones or by providing limited access roads to the airports (e.g. Dulles Airport outside of Washington, D.C.). Where the control of development will be difficult will be in conjunction with reliever airports. There is evidence that already business is beginning to cluster around reliever facilities (see "Airport Siting" study in Appendix C).. Such a trend may make it advisable for EPA to change its proposed review standard to include more airports than just those falling within the 50,000 or more annual commercial operations category. More research is needed, however, to determine if such a change is indeed justified.

d. Highways

The impact of highways in facilitating a dispersed population pattern was discussed previously under Part II, Section B-3. The state-of-the-art in reviewing decisions to construct new highways or to expand existing systems has been greatly improved through the requirements to prepare environmental impact statements. Still, in terms of overall effect on environmental quality, there remains a need to examine alternatives within a broader context than just which proposed route will remove the most historical landmarks, parklands, or wetlands. The issues of whether the proposed construction should be permitted at all or whether public transit could reduce the projected demand deserve greater stress in the review process. Highway projects would also benefit from consideration in the context of comprehensive land use plans. In addition, the total direct and indirect impact of the proposed highway on the urban and suburban growth pattern as previously discussed, have important environmental implications. EPA's consultative role to the Federal Highway Administration may be of great advantage as a means of assisting the Administration in the development of appropriate guidelines for evaluating environmental impact of a project in terms of the probable changes in growth patterns which may occur.

Another issue of some interest is the growth induced around intersections. Although this has been an important issue in the past, it is now expected to be of lesser importance, as the Interstate Highway System nears completion (at present more than 98 percent of the system is in place). The Federal Highway Administration is currently sponsoring a series of studies on increasing public benefits from new highway construction through planned development at intersections either as privately sponsored multi-use projects or through public initiative, utilizing tools such as excess acquisition and special district zoning. The results of these studies and the degree to which they are incorporated into public policy may also have a significant effect on highway induced growth.[1] In this connection, it is worthy of note that for waste treatment facilities - another type of growth inducer, as shown in Chapter II, Section B-3 - Region I has already been investigating the multi-use of lands and easements acquired for such facilities to secure open space and to provide recreation access and opportunities.

e. Other Indirect Sources

Until the 1950's there were less than 100 industrial parks scattered across the country. By 1970 there were more than 2,400 industrial parks.[2]

Seventy-eight percent of the industrial parks have been established since 1960 and over half have been established since 1965. California leads the nation in numbers of industrial parks. Other high ranking states are Texas, Missouri, Illinois, Michigan, Ohio, Pennsylvania, and New Jersey. In terms of location factors:

> Two decades ago, a number of trends began to influence the the growth of industrial parks. Industry, looking at the increasingly apparent problems of the central cities, sought out suburban plant sites where land was cheaper, taxes were lower and where there was more elbow room to accommodate the long, linear plants required by new methods of production and material handling. Real estate developers, anticipating

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[1] For additional information on intersection related development, see the "Highway" study in Appendix C.

[2] "Proliferating Industrial Parks Spark Plant Location Revolution," Industrial Development (March/April 1970). p. 7.

Standards established by the National Industrial Zoning Committee (NIZC) stipulate that an industrial park must be a single tract of at least 25 acres and that ownership and/or control of the land should be vested in a single body with an established financial responsibility.

> that easier access to the suburbs via high-speed highways would spur industry's exodus from the central cities, rushed to develop sites in park-like environments to meet the demand.
>
> The fantastic growth of industrial parks has been called the most significant factor influencing plant location in recent years. One indication of that influence was a recent report by one developer that some 60 percent of all new industrial construction on the West Coast in sizes ranging from 10,000 to 100,000 sq. ft. is going into industrial parks.

Transportation has and continues to be an important factor in the siting of industrial parks - a fact which has certain important implications in view of the proposed indirect source regulations. In 1966 Industrial Development identified some 200 industrial parks fronting on Interstate highways whereas by 1970 about 430 were so identified. Some parks have been designed to link to containerization facilities or to airports. In the latter instance the burgeoning fleet of corporate and private aircraft has resulted in increasing demand for fly-in parks. In 1970 there were 57,546 general aviation airplanes registered by 22,692 corporations and more than 50,000 individually-owned aircraft which were often piloted for business purposes. Almost every state has at least one fly-in industrial park.

In addition to the transportation-oriented parks, a new concept in industrial park development which has been receiving widespread attention over the last two years is the "decoplex". A decoplex is a planned area which combines in one site two or more interdependent units which contribute to such vital community objectives as waste processing and/or energy production, environmental protection, and economic development. Examples of this type of development include a joint effort between the Atomic Energy Commission and Texas A & M to create a nuclear-agricultural combination.

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[1] Idem

[2] Ibid, p. 8

[3] "Is There a Decoplex In Your Future?" Industrial Development (May to June, 1972), p. 2.

Elsewhere, members of the University of Rhode Island have drawn up plans for a nuclear power plant combined with a sewage treatment facility on Naragansett Bay. Waste heat from the power plant will be used to activate the sewage plant and to furnish heat to a new town to be built around a new lake. In addition, researchers at the University of Arizona have proposed a "solar power farm," which would use a large land area for trapping heat from the sun - the energy to be stored in molten chemicals for delivery to a power plant.[1]

In the past, EDA[2] has made several efforts to use industrial parks to help spur on general development in areas suffering from high rates of unemployment (e.g. Indian reservations). These efforts, however, have fallen far short of their goal, in large part because of the remoteness of the test sites from good transportation networks. The most successful parks, on the other hand, have been those in suburban locations with good access to major population centers, these facilities usually also generate a significant amount of traffic which, from an environmental point of view, may be more troublesome than that associated with a shopping center, because it coincides with other peak hour commuter traffic.

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[1] Ibid, p. 4

[2] The Economic Development Administration of the U.S. Department of Commerce.

The new trends towards decoplexes and fly-in parks will probably be most notable in terms of the future growth that may be induced by such facilities. At present, however, both types of development are too new for specific patterns to be discernible. Trends in the location of industrial parks with respect to railroad facilities is another topic which requires further data to be collected.[1]

Another category falling under indirect source regulations is large-scale amusement parks and recreational facilities. In contrast to shopping centers, these facilities are being built further and further away from existing urban centers. "Amusement parks once hugged the edges of big cities. Now they are situated miles from metropolitan centers but where superhighways can bring customers from a radius of 100 miles or more."[2] The new parks are built around history, fantasy, the world of nature, or even the religious revival. Although there is some indication of financial difficulties for some of the parks, the interest in this type of development and the general location trend seem to be strong.

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[1] Industrial growth as distinct from that occurring in industrial parks is discussed up under the "Regional Impact" section to this report.

[2] "The Profit in Amusement Parks" Business Week (June 24, 1972) p. 116.

f. Indirect Sources: Conclusions

In general, shopping centers appear to be headed in a direction of less traffic inducement in the future. Sports stadiums, industrial parks, and recreational facilities, on the other hand, will probably continue to attract traffic in magnitude and patterns similar to the last few years. Airports will probably exert a greater impact in the future. In all cases a greater emphasis deserves to be placed on investigating the potential for public transit links.

In terms of growth patterns, the influence of highways and shopping centers will probably lessen, while that of airports, stadiums, recreational complexes, and industrial parks will probably increase - although in the latter case the trends are not altogether clear.

5. New Towns

According to HUD estimates, new communities will absorb 15 to 20 percent of projected national growth over the next three decades, a relatively low figure when placed in a managed growth versus urban sprawl context.[1] The Rockefeller Task Force report provides a partial explanation for this low estimate. The Report highlights lack of managerial experience as the key barrier to large scale development.[2] Other problems include inadequate demand, securing proper financing, arranging for land assembly, and obtaining the necessary utility services, zoning, and local acceptance.

There are presently about 150 "New Towns, Communities and Large Developments" in various stages of planning and/or construction. Their total planned population is over 9 million, with an average size of about 60,000.[3] Almost all these developments will be concentrated around existing centers of population concentration (see Exhibit X). For example, of 10 new communities which have already been approved by HUD (with an estimated population of 687,000), nine will be in suburban locations 10 to 30 miles from a metropolitan center (see Exhibit XI).

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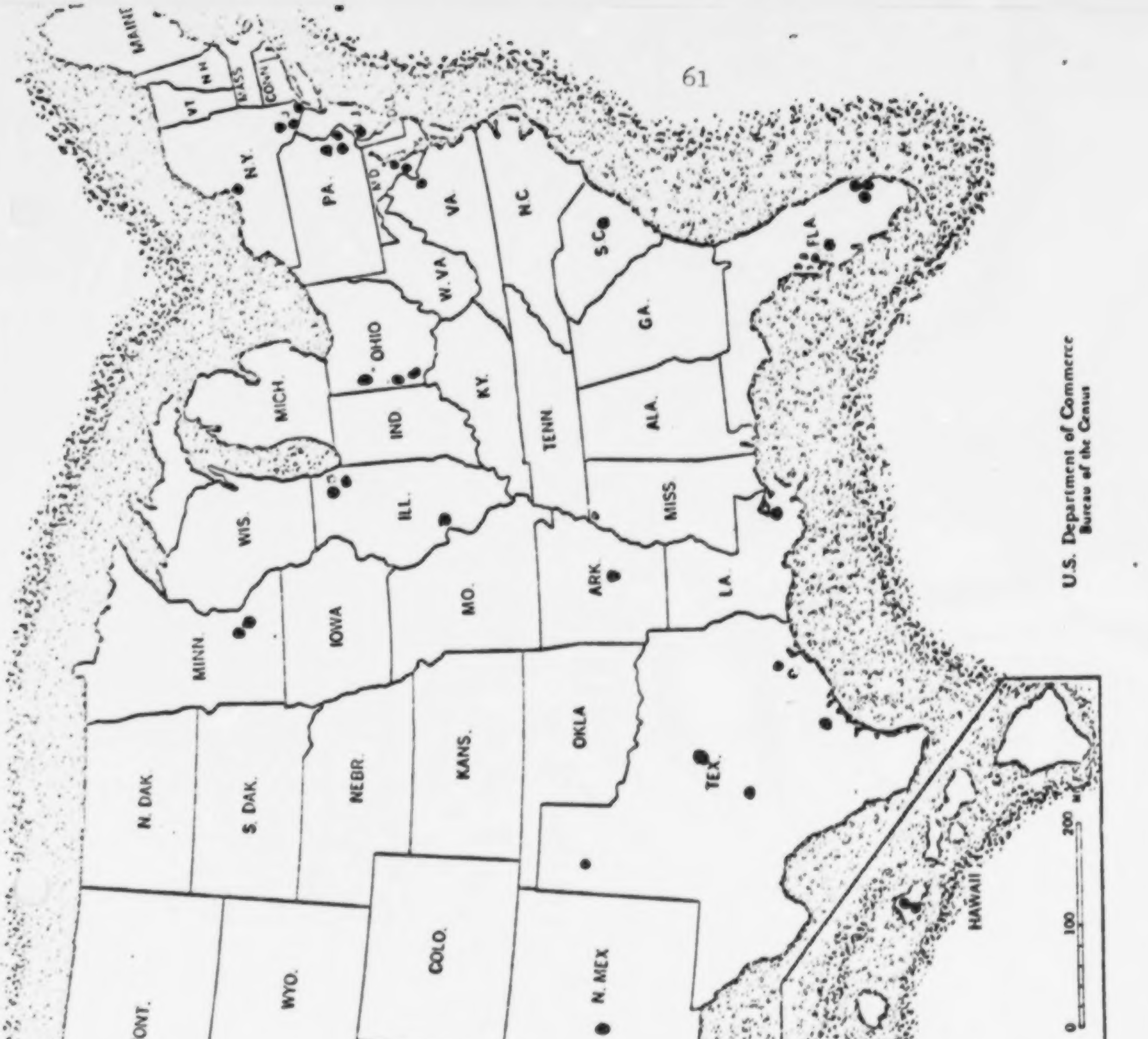
[1] Samuel C. Jackson, "New Communities," *HUD Challenge*, August, 1972. HUD is the U.S. Department of Housing and Urban Development.

[2] Reilly, *op. cit*. p. 255.

[3] U.S. Postal Service. *New Towns and the U.S. Postal Service*.1973, p. 6.


MAINE
N.H.
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N.J.
DEL.
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VA.
W. VA.
N.C.
S.C.
GA.
FLA.
OHIO
MICH.
IND.
KY.
TENN.
ALA.
MISS.
ILL.
WIS.
MINN.
IOWA
MO.
ARK.
LA.
N. DAK.
S. DAK.
NEBR.
KANS.
OKLA.
TEX.
MONT.
WYO.
COLO.
N. MEX.
IDAHO
UTAH
ARIZ.
WASH.
OREG.
NEV.
CALIF.
HAWAII
ALASKA
U.S. Department of Commerce
Bureau of the Census
100,000 and over
75,000- 100,000
50,000- 75,000

Exhibit X

Planned New Towns With Population
Greater Than 50,000

Source: U.S. Postal Service. New Towns and the U.S. Postal Service 1973.

Only one of the ten new towns shown in Exhibit XI, is a new-town-in-town, although Chicago has plans now for such a development to provide housing for 120,000 residents.[1] While there are few free-standing new towns like Soul City the scarcity of new towns based on a rural economy reflects the reservations of the financial investor and the absence of appropriate managerial capability. One exception to this general trend, however, is the General Electric proposal for a new town (Seabrook Farmington) for 45,000 to be developed in a rural and sparsely populated part of New Jersey. Plans call for leaving about half of the 6,000 acre tract in farms and open space. Another 12,000 acres have been leased to Seabrook Farms to continue vegetable growing and processing operations.[2] Another projected development that would be based on a rural location, are the plans by El Paso Natural Gas Company to establish a community in conjunction with a new coal gasification complex in the western Four Corners Region. The Department of Economic Development of the State of Maine, is also investigating the potential of setting up a new town as part of an integrated silviculture, lumber and paper processing operation.

A variety of studies indicate that new towns are in the public interest economically, socially, and environmentally. As the Rockefeller report points out, "...increased scale brings significantly greater opportunity to create quality", though quality is not necessarily guaranteed. In part the expectations of increased quality through new town development are based on a broad range of economic, social, environmental, and governmental objectives which a new community must

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[1] "Chicago 21" Time. July 2, 1973, p. 59.

[2] Planning. August 1973, p. 5.

Exhibit XI

SUMMARY OF NEW COMMUNITIES FINANCING GUARANTEED BY HUD
(Dollars in Thousands)

	HUD Guarantee Commitment	Guarantees Issued		Supplementary Grant Reservations Amount/Date					
Community Name	Amount Date	Amount Date	Interest Rate	Water & Sewer	Open Space	Other	Population (Projected)	Dwelling Units (Projected)	Location
Jonathan, Minnesota	$21,000 2/70	$21,000 6/72 a	7.20%	$216 6/70	–	–	50,000 20 years	15,500 in 20 years	20 mi. S.W. of Minneapolis
St. Charles Communities, Maryland	$24,000 6/70	$18,500 12/70 a	7.75%	$757 6/70	$102 6/70	$900 6/71 (EPA)	75,000 in 20 years	24,872 in 20 years	25 mi. S.W. of Washington, D.C.
Park Forest South, Illinois	$30,000 6/70	$30,000 3/71	7.00%	–	$176 5/71	–	110,000 in 15 years	35,000 in 15 years	30 mi. S. of Chicago
Flower Mound, Texas	$18,000 12/70	$14,000 10/71	7.60%	–	–	–	64,000 in 20 years	18,304 in 20 years	20 mi. S.W. of Dallas
Maumelle, Arkansas	$ 7,500 12/70	$ 4,500 6/72	7.62%	$330 6/71	–	$231 6/71 (EPA)	45,000 in 20 years	14,390 in 20 years	12 mi. N.W. of Little Rock
Cedar-Riverside, Minnesota	$24,000 6/71	$24,000 12/71	7.20%	–	–	–	30,000 in 20 years	12,500 in 20 years	downtown Minneapolis
Riverton, New York	$12,000 12/71	$12,000 5/72	7.125%	–	–	–	25,600 in 16 years	8,010 in 16 years	10 mi. S. of Rochester
San Antonio Ranch, Texas	$18,000 2/72	–	–	–	–	–	88,000 in 30 years	28,676 in 30 years	20 mi. N.W. of San Antonio
The Woodlands, Texas	$50,000 3/72	–	–	–	–	–	150,000 in 20 years	49,000 in 20 years	30 mi. N. of Houston
Gananda, New York	$22,000 4/72	–	–	–	–	–	50,000 in 20 years	17,200 in 20 years	12 mi. E. of Rochester
Cumulative Total	$226,500	$122,000			$2,712		687,000	223,452	

a Guaranteed under Title IV, HUD Act of 1968; all other guarantees under Title VII of HUD Act of 1970.
June 26, 1972

Source: HUD Challenge. August 1972.

satisfy, if it is to gain HUD support under the New Community Development, Title IV of the Housing Act of 1968 and its expansion in 1970 under the Title VII of the Urban Growth and New Community Development Act. These objectives include:

- Urban Growth - New communities must contribute to orderly national growth, by encouraging full use of the economic potential of smaller towns and rural communities, or by strengthening metropolitan areas through revitalization of existing older cities and orderly growth in undeveloped suburban areas.
- Equal Opportunity - New communities must reduce economic and racial polarization in the Nation by offering choices for living and working to the fullest range of people and families of different composition and income; they must be open to all people, regardless of race, religion, sex, or ethnic origin.
- Environmental Quality - New communities must preserve and enhance both natural and urban environments. They must be designed with a sensitivity to natural environmental constraints and opportunities; they must seek to minimize air, water, noise, and soil pollution, and they must promote the highest standards of urban, architectural, and landscape design quality.
- Strengthen State and Local Government - An important part of the new Federation and national urban growth strategy is increasing the capacity of State and local governments to deal effectively with their own growth problems.
- Innovation - New communities are to be laboratories for testing desirable physical, social, and economic innovations aimed at meeting domestic problems.[1]

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[1] "New Communities," HUD Challenge. August 1972, pp 4-5.

Although in nature and scope these objectives deserve praise, there is evidence that far from optimum plans are being developed. For example, although plans for new communities are generally superior in terms of designing internal movement of goods and people, there is very little concern with integrating the development's transportation system with areas outside the boundaries. As of 1972, Park Forest South, near Chicago, was the only federally guaranteed new community in the United States with a definite commitment for a rail rapid transit connection to the central city to which it relates.

Another example of planning problems associated with new towns is the controversy that has developed over the San Antonio Ranch development. Opponents to the project argue that the proposed site, lying directly over the recharge zone of the Edwards Underground Aquifer, will have a deleterious effect on the source of San Antonio's only supply of water. The developers, on the other hand, point out that if their project is killed development would continue in the present fashion with one-acre lots using septic tanks or with hastily constructed subdivisions with "below-par environmental safeguards that would not have to face federal scrutiny." [2]

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[1] *HUD Challenge* p. 7

[2] "The Big Troubles at San Antonio Ranch", *Business Week*, November 3, 1973, pp. 78-79.

Although some of the environmental impact statements filed by developers of proposed new towns show a fairly sophisticated understanding of the enviromental consequences and control measures of their developments (e.g. the Welfare Island New Community EIS), the specific implementation of efforts such as recycling,heat transfer and so forth are often planned far down the line in terms of phased expansion programs.

In some of these perhaps weaker areas of new town planning, EPA may excercise some leverage due to the importance of federal funding to new communities. Although only 13 of the approximately 150 new towns and large developments that are presently in an active stage of building have thus far received HUD-guaranteed loans, many more are in the offing. For example, of the remaining 137 new communities, 14 have applications pending with HUD. Even more importantly, there are about 100 additional developers who either have made application to HUD for loan guarantees or who have made what HUD calls "serious inquiries" as to the possibility of receiving such guarantees. Their projects are not listed as possible "new towns, etc." by the urban experts since it is unlikely that they will even be started unless they receive HUD guarantees.[1]

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[1] U.S. Postal Service, op. cit., pp 3-4.

C. The Rural-Urban Interface

1. The Problem

About one-fifth of the land devoted to the production of crops and livestock is classified as cropland, of which about 75 percent is used for crop production each year, with the remainder lying fallow or in some other use. Livestock is grazed on 41 percent of the land. About one-third of the land use primarily for livestock production is also devoted to other uses, mainly crops and forests.

With respect to environmental quality and land use, the important issues are largely related to dynamics along the urban-rural interface where expanding development overtakes better quality farmland, resulting in pressures to increase production from other agricultural lands and/or expansion of farming into more critical environmental areas. Consequently, the boundaries of agricultural land in a nationwide perspective are characterized by antithetical trends of withdrawal and expansion. On the one hand, there is the annual reduction in land devoted to agricultural use. The Department of Agriculture estimates that 8 million acres of land each year, excluding surface mining, are converted to nonagricultural use.[1] About half of this represents shifts to uses such as wildlife refuges, recreation areas, and parks, while an additional 160,000 acres are covered by highways and airports, approximately 420,000 acres become reservoirs and flood control projects, and an estimated 420,000 acres are developed for urban uses.

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[1] The President's Message to Congress of August 10, 1970, transmitting Chapter IX of the First Annual Report of the Council on Environmental Quality.

On the other hand, there is new acreage being brought into agricultural production each year. From 1944 to 1964, roughly 22.5 million acres were brought into production through private and Government-assisted drainage and irrigation programs.

In balance for every two acres that went out of agricultural use, about one acre of new cropland was developed. In terms of farm output, however, "the land drain (i.e. conversion of land to non-agricultural use) is not as bad as it looks." "Much of the new land is more productive than that abandoned. This is due primarily to the fact that most of the new land being brought into production is irrigated land which emphasizes the importance of proper water use planning."[1]

In addition, improved technologies - mechanization, improved varieties of plants and breeds of animals, chemical pesticides, and synthetic fertilers - have permitted greater production on existing farmland. Consequently, while the amount of acreage in crops decreased by 9 percent between 1950 and 1970, total farm output increased by 40 percent.[2]

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[1] Statement of John W. Scott, Master of the National Grange, in U.S. House of Representatives. Hearings before the Subcommittee on the Environment on Land Use Planning Act of 1973 (March 26 & 27, April 2, 3 & 4, 1973), p. 624.

[2] U.S Senate Committee on Interior and Insular Affairs. Background Papers on Past & Pending Legislation and the Roles of the Executive Branch, Congress, and the States in Land Use Policy Planning (April 1972), p.33.

Still, the increase in production has been achieved only at some expense to the environment. There are several reasons for this. First, there is the quality of land involved in the conversion and reclamation processes. Recent trends in land use seem to indicate that urbanization favors the use of better quality farmland. In 1964, the Standard Metropolitan Statistical Areas (SMSA's) had some 7 percent of the total farms and 14 percent of the harvested cropland. At that time 15 percent of the U.S. wheat, 17 percent of our corn, 60 percent of our vegetables, and 43 percent of our fruits and nuts were produced within metropolitan areas. The SMSA's also contained about 15 percent of the better land, i.e. of Land Use Capability Classes I, II, and III.[1] One study of 98 northeastern counties has found that about 80 percent of the agricultural land converted to urban use was former cropland of Classes I-III.

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[1] The U.S. Soil Conservation Service has developed eight land capability classes, distinguished according to the risk of land damage or the difficulty of land use. These classes are:

Land suitable for cultivation and other uses.

I. Soils in class I have few limitations that restrict their use.

II. Soils in class II have severe limitations that reduce the choice of plants or require special conservation practices.

III. Soils in class III have severe limitations that reduce the choice of plants or require special conservation practices, or both.

IV. Soils in class IV have very severe limitations that restrict the choice of plants, require very careful management, or both.

Land generally not suitable for cultivation (without major treatment).

VI. Soils in class VI have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

VIII. Soils and landforms in class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Second, some serious questions can be raised regarding the quality of the land outside of the SMSA's. In 1967, approximately 97 percent of privately owned, non-Federal rural land had soil limitations or conservation problems. Water erosion was a limitation on 51 percent or 286 million hectares (706 million acres). On cropland only, water erosion was a dominant limitation on 55 percent or 89.5 million hectares (221 million acres).[1]

Wind erosion is a problem in any area of low, variable precipitation, where drought is frequent, and temperatures, evaporation, and windspeeds are high. It is the dominant problem on about 22.3 million hectares (55 million acres) of cropland and 3.6 million hectares (9 million acres) of rangeland.[2]

Altogether the area of agricultural land suffering from erosion increased by slightly more than four percent between 1958 to 1968. Erosion is especially a problem in the Plains States and Appalachian region. Other problems inpacting pasture and cropland are:

- Excess Water - 246 million acres. Excess water is the most serious difficulty in the Lake States and the Delta area.
- Soil Deficiencies - 352 million acres. Soil deficiencies are the chief problem of the Northeast and Mountain States.

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[1] U.S. Department of Agriculture. Basic Statistics: National Inventory of Soil & Water Conservation Needs 1967 (Stat. Bul. No. 461, 1971).

[2] Idem.

- Adverse Climate - 75 million acres. The chief areas with adverse climate problems are the Plains and Mountain States.

U.S. Department of Agriculture studies have further indicated that only about one-third of the acreage with erosion, excess water, soil deficiencies and adverse climate has been receiving soil conservation treatment.[1]

In addition to the "land drain" problem, pressure is also being placed on agricultural land due to ever increasing food demand both for internal consumption and export. In terms of future requirements for agricultural land to meet our food needs, based upon fairly conservative assumptions for productivity and population growth, the OBERS report to the Water Resources Council predicted that approximately 310 million acres of cropland must be harvested by the year 2000 to grow enough crops to meet U.S. domestic and export needs. This figure compares to 333 million acres of cropland in 1954 and 287 million in 1964.[2] The CEQ report indicates that the OBERS projections are already proving to fall short of the mark with respect to increased demand for exports and that short-term supply problems may result. In both the near and long-term, then, there will be a need to expand agricultural land or increase production from existing farmland.

The possible environmental implications of increased output from new and/or existing land are numerous and deserve careful consideration. For example, one commonly held opinion is that output can most effectively be increased through the expansion of one-crop farming (monoculture) on large areas suitable for mechanized production. Recent evidence, however, indicates that large farms do not necessarily have higher yields per acre for all crops. A comparison made among wheat farms in the Nebraska Panhandle showed that size-of-farm made no difference in per acre yields of wheat, despite the fact that the smaller size farms spent the least amount on fertilizers and chemicals. In another study, conducted in Mississippi, there was clearly an increase in yields of cotton, corn and oats as farm size increased, but farm size made no difference in yields of soybeans and wheat.[1]

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[1] U.S. Senate Committee on Interior Insular Affairs. Background papers papers op. cit. (April 1972) p. 45.

[2] Council on Environmental Quality. Fourth Annual Report (Sept. 1973) p. 307.

In general then, there is not a very close or consistent connection between farm size and yield; yet the larger farms tend to have a much greater potential for adverse social and environmental impact. The new technology of mechanization, for instance, by replacing human labor and by forcing farms too small to mechanize and compete to go out of business has provided an impetus to "the mass migration of millions of agricultural workers to cities ill-prepared to receive them, and the loss of the social benefits of the small farm based communities."[2] In addition, large farms place a heavy dependence on the use of fertilizers and biocides to produce higher yields per acre. A 1964 study found that farmers with gross sales of over $40,000, occupied only 28 percent of all the lands in agricultural production but accounted for 40 percent of all pesticides used. In contrast, farmers with gross sales under $5,000, occupied 9 percent of the total farm acreage and used 11 percent of all the pesticides. Between these two extremes, medium-sized farms accounted for 63 percent of all acreage and 49 percent of pesticides applied, indicating that pesticides are used most efficiently in this middle range.[1] The overdependence on one crop under a monoculture system can lead to increased use of pesticides to protect the harvest. This, in turn, can result in insect strain mutations and elimination of natural systems of control, and even greater dependence on pesticides. The tendency to perhaps over rely on pesticides is re-inforced by the fact that large farm operators do not necessarily spend more for the greater quantities that they buy, since they are given volume discounts (See Exhibit XII). Yet, despite these problems

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[1] Michael Perelman and Kevin P. Shea. "The Big Farm" Environment (Vol. 14, No. 10, Dec. 1972), p. 11.

[2] Ibid, p. 10

EXHIBIT XII

RELATIONSHIP BETWEEN FARM SIZE AND COST OF CAPITAL AND OTHER PURCHASED INPUTS

Farm Size (acres)	Interest on Operating Capital (6% norm)	Volume Discount on Fertilizers	Volume Discount on Insecticides	Volume Discount on Crop Dusting & Aerial Spraying	Total Difference from Base Cost per Acre
80	6.88%	0%	0%	0%	$0.56
160	6.52%	4%	0%	0%	-$0.25
320	6.47%	4%	5%	0%	-$0.53
640	6.47%	4%	5%	12.5%	-$1.27
1,230	6.15%	10%	8.5%	17.5%	-$3.96
3,200	5.90%	10%	14%*	25%	-$6.62

*Denotes only one observation behind the data.

Source: Paris, J.E., and D.L. Armstrong, **Economics Associated with Farm Size, Kern County California Cash Crop Farms,** Giannini Foundation Research Report No. 269, 1963, pp. 73-96.

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[1] *Ibid*, p. 11

the trend towards larger farms continues. Since 1945, the size of the average farm in the U.S. has doubled, from 191 acres to 394 acres.[1] And in terms of the potential rate of increased use of fertilizers and pesticides to achieve higher levels of output, one estimate is that a doubling of food crop production will require a sixfold increase in the use of pesticides and a hundredfold increase in the use of fertilizers.[2]

Other methods of increasing food production include expanding cultivation into areas of more rugged topography or into new arid areas brought under irrigation. Both these measures, nevertheless, would require the judicious application of land management techniques in order not to aggravate any further non-point source water pollution. At present croplands already rank as the largest producer of sediment. About two billion tons from the source are washed into the streams in the United States each year and is the greatest single contributor of nitrogen and phosphorus to water.[3]

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[1] "Agriculture: Biggest Growth Industry in the U.S." Business Week, (April 28, 1973) p. 64.

[2] Speech given by Dennis Meadows at the First National Conference on Managed Growth, (Chicago, September 16, 1973).

[3] U.S. EPA. Methods for Identifying and Evaluating the Nature and Extent of Non-Point Sources of Pollutants. (Wash. D.C., 1973) p. 39

Due to the increasing trend towards larger farms which, in turn, tend to use relatively greater proportions of biocides and fertilizers per acre, the question arises as to whether the management techniques for controlling non-point sources of pollution from agricultural lands are being or could potentially be better applied on large-size versus small-size farms.

In addition to runoff containing fertilizers and biocides, there is the problem of livestock waste. According to the U.S. Department of Agriculture (USDA) about two billion tons of livestock wastes were produced in the United States during 1972. This volume of animal waste is about 10 times that produced by the human population. Approximately half of this waste is produced by animals in confined feeding.[1] The management of animal wastes has received considerable attention in recent years because of their water and air pollution potential. Much of the concern over a major trend toward large confined livestock and poultry operations has resulted because confined feeding operations lead to vast accumulations of wastes in localized areas.

The most common and ecologically accepted method for disposing of wastes from feedings facilities is application to the land. This is also the lowest cost method of disposal for most systems.[1] The practice emphasizes utilization of the wastes as primary plant nutrients in a recycling process:

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[1] U.S. Dept. of Agriculture. Methods and Practices for Controlling Water Pollution From Agricultural Nonpoint Sources. Prepared for U.S. EPA (Draft Report, Sept. 7, 1973), p. 54.

> The waste produced per animal unit can be applied on less land than is required to produce feed for an animal unit. The application rate is determined largely on the basis of the nitrogen content of the waste and the plant species grown. Weed seeds, salt content, and toxic substances may become limiting factors under some conditions....When sufficient cropland is not available, large amounts of manure are sometimes applied to land with emphasis on disposal rather than plant utilization although this practice can alleviate disposal problems, it can create other problems. Nitrate, salts and other compounds may accumulate to undesirable levels in the soil profile, or leak into underground water supplies.[1]

The land disposal of animal wastes requires significant acreage. It is estimated that to maximize the utilization of waste, approximately one hectare (2.4 acres) of land is required for every 3 to 6 dairy cows, 5 to 10 beef animals, 20 to 40 hogs, and 400 to 800 chickens.[2]

Much remains to be learned of the implications of these requirements in light of the changing, patterns of rural land use, described previously.

In the case of confined animal facilities, most of these should include a system for capturing and disposing of storm runoff. This problem is greatest in areas of high rainfall, where about one-fourth to one-half of the annual precipitation ends up as run-off. Because of this, it would be useful to have studies made that focus on the total differential environmental impact of confinement areas for regions with moderate or heavy rainfall or which are within semi-arid or arid zones. Trends in feed lot locations and changes due to increasing operating costs of confinement areas due to soaring feedgrain prices should also be examined.

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[1] Idem

[2] Ibid, p. 55.

Irrigated farming presents other problems. Of the estimated 339 billion gallons of water consumed daily in the United States more than 35 percent is used for agriculture. About 6 percent of irrigation water is lost by evaportranspiration while the remainder is returned by surface runoff and subsurface flow to surface waters and to ground water storage. The return flows carry large quantities of minerals which can degrade the water quality of the receiving streams.[1]

2. Other Elements Affecting Rural Land Use

In the previous section the problem of changes in land use along the rural-urban interface and the environmental implications of these in terms of increasing pressure to produce more from existing agricultural land and to open up new areas to farming was discussed. There are other types of land use, however, that have a similar effect in generating pressure on agricultural development but which are dispersed, localized occurrences and not part of the interface *per se*. For example, an issue which is increasingly of concern to western ranchers is the potential conflict between livestock raising and the proposals for opening vast areas to coal and oil shale development. This issue and its implications for water supply and quality in arid and semiarid regions is discussed as a special case under the "critical areas" heading of this report.

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[1] Other types of environmental impacts are described in the "Agriculture Land Use Study", to be found in Appendix E of this report.

Another element of some importance is the conversion of land to residential use, when this is a process distinct from the general direction of urban growth. For example, although the rural population has been decreasing at relatively steady rate over the past 50 years, residential demand has been increasing. One study found that about 600 counties which lost population in recent years gained in the number of housing units, largely as a result of the decreasing size of the average family.[1]

A far more important trend, however, is the rising number of second homes. The National Association of Home Builders estimates that two to three million Americans now own second homes and this figure is increasing each year.[2] And such statistics are just the tip of the iceberg. HUD's Office of Interstate Land Sales Registration has estimated that in 1971 for each second home erected, five more lots were sold for future development.[3]

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[1] Robert Cassidy, "America Outside the Cities and Suburbs" Planning (August 1973), p. 7

[2] U.S. House of Representatives. Hearings Before the Subcommittee on the Environment on Land Use Planning Act of 1973 (March, April 1973), p. 372.

[3] David R. Mosena of Frank J. Popper "Leisure Homes Urbanize the Countryside" Planning (August 1973) p. 20.

The environmental consequences of such a rate of development can be enormous. As an illustration, in 1970 the California State Division of Soil Conservation announced that between 1965 and 1973 approximately 500,000 acres of land had been subdivided in the California foothills, resulting soil loss, stream pollution, and loss of natural and wildlife values. Thirty-seven percent or 160 miles of the stream mileage in the Sierra foothill county of Nevada within California had been damaged from steambank alterations, siltation, and sewage and waste discharge resulting from new large-scale leisure home developments.

There are other types of land use which are growing in rural areas, such as recreation and silviculture, but according to the National Grange, these have very minor impact and are often amenable to multi-use.[1] Some industrial development is also occurring, but its significance is reflected more at the regional level and, therefore, is discussed under the "Regional Implications of Growth" section of this report.

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[1] U.S. House of Representatives. Hearings Before the Subcommittee on the Land Use Planning Act of 1973 (March & April 1973).

In summary, a number of pressures are currently affecting the use and reuse of farm and ranchlands. In view of the possible adverse environmental impacts of the alternatives for raising the levels of agricultural output, it will be important in the future to preserve agricultural lands on good soils where land management techniques can best be applied. There have been some positive efforts in this respect. So far 30 states have passed laws, most of them based on taxation techniques, to help keep farmland as farmland. Many state planners and officials are looking to assistance in this effort from the proposed National Land Use Policy Act. "Under the grants program of the bill, the most sensitive agricultural lands will be set aside by States as areas of critical environmental concern and States will develop orderly growth programs to shield agricultural land from suburbanization."[1]

D. Non-Degradation

1. Introduction

The purpose of this analysis is to examine non-degradation from a land use perspective; that is, which land consuming sources are potential threats to the maintenance of air and water quality. Media degradation can occur in any location regardless of the current level of environmental quality. Most recently the term has been receiving wide-spread publicity as a result of efforts to determine a legal definition of "significant deterioration" of air quality under the Clean Air Act, especially for relatively pristine areas (areas with air quality better than secondary standards.[2]

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[1] Land Use Planning Reports, (Vol. 1, No. 18) November 5, 1973, p. 5.

[2] The secondary atmospheric quality standards are: particulates, 60 micrograms, annual; 150 micrograms, 24 hours; sulphur dioxide, 60 micrograms, annual; 260 micrograms, 24 hours; 1300 micrograms, three hours. A microgram is a millionth of a gram.

There is concern over maintaining air and water quality in relatively untouched regions, on the one hand, and concern with the impact of relatively strict standards on future patterns of land use and economic development on the other. In announcing the proposed regulations for the prevention of significant deterioration of air quality, Robert Fri, then acting EPA Administrator, stated, "However defined and implemented, it is clear that a national policy of preventing significant deterioration will have a long-lasting impact on the nature, extent and location of future industrial, commercial and residential development throughout the United States."[1]

The section below describes regional and area land use trends in conjunction with non-degradation. This is followed by an impact study on the implications of the proposed non-degradation policy for air quality for projected growth and development. In the case of water quality, no in-depth study of the non-degradation issue has been undertaken. The general mapping of the pollution density index was used in relation to projected industrial and population growth. While agricultural and other resource development practices which can lead to water contamination may increase in areas with pristine waterways, there are no means of determining, at this time, the implications of a non-degradation policy nor of assessing the impact of a program to maintain these waterways in their current state.

2. Regional and Area Land Use Trends and Non-degradation

The focus of much concern has largely been on the siting of specific industrial facilities which directly account for most of the non-mobile sources of air pollution (while also generating traffic requirements resulting in mobile source emissions and which are major discharges of effluents of thermal pollution affecting water quality.

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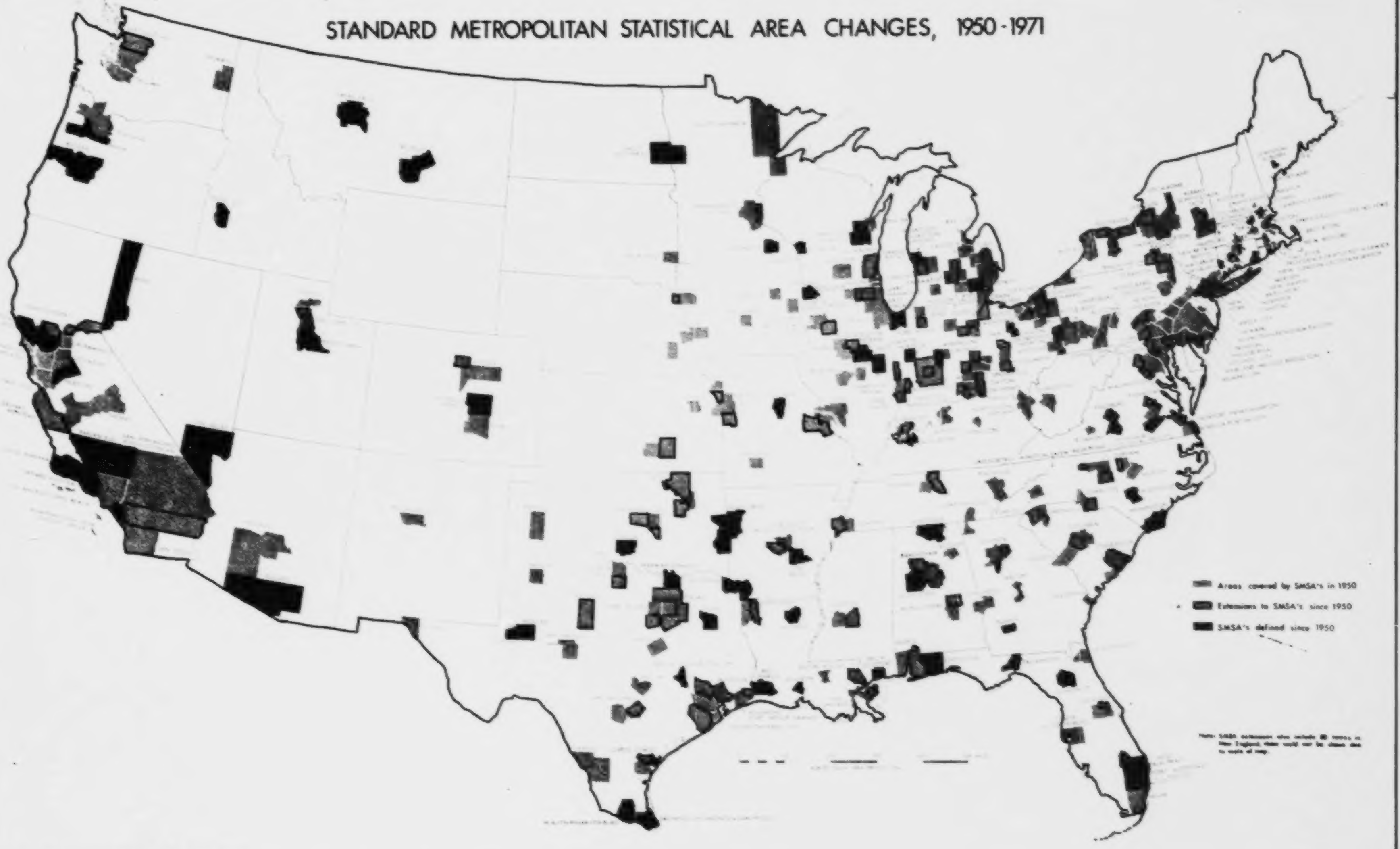
[1] *The New York Times*, July 14, 1973.

The implications of non-degradation, therefore, raises the question of what are the dominant trends in industrial location over the next ten to twenty years? What regions or areas will face the greatest problems in terms of possible water degradation and/or significant deterioration of air quality? Will those problems be concentrated largely in SMSA's or rural areas?

To help answer these questions, a series of maps have been prepared and are presented in the pages that follow. The base map shows the location of existing SMSA's and their growth patterns from 1950 to 1971 and the planned construction of new power plants from 1972 to 1980. The first overlay shows some of the announced sites for new plants between 1973 and 1985 for industries falling under the proposed non-degradation regulations. By superimposing the water and air quality overlays on the plant location map, it can be seen that:

- Approximately half the sites excluding power plants, will be in areas suffering from moderate to severe water pollution;
- The large majority of non-power plant industries will be in priority I AQCR's;
- With the exception of the copper smelters and some sulfuric acid plants almost all the non-power plants will be within or at the edges of existing SMSA's;

STANDARD METROPOLITAN STATISTICAL AREA CHANGES, 1950-1971


▨ Areas covered by SMSA's in 1950
▨ Extensions to SMSA's since 1950
■ SMSA's defined since 1950

Note: SMSA extensions also include 80 towns in New England; these could not be shown due to scale of map.

Base Map - U.S. Department of Commerce, Bureau of the Census

- More than half of the planned power plants, over the near-term will be in priority I AQCR's (thereafter, the greatest expansion will be in relatively pristine areas in conjunction with the development of western coal and oil-shale reserves);
- The majority of the power plants will be sited in areas with moderate to severe water pollution problems;
- With few exceptions, power plants are being sited outside of SMSA's;
- The dominant pattern for both power plants and other industries is location along coastal zones and inland waterways.

If these are the trends for power plants and some of the most important point-sources of air pollution, what are the trends for other types of industrial activities?

There is evidence - following recent trends - that the greatest level of growth will be experienced in the South, followed by the West. In the South, for example, manufacturing jobs rose by 42.9% compared to 15.5% for the nation. Employment in such industries as rubber and plastics, transportation equipment, and electrical and non-electrical parts more than doubled, boosting their share of total manufacturing from 11% to almost 20% by the end of the 1960's.[1]

Oil in Texas and along the Gulf Coast provides another case. It has produced an enormous petrochemical industry. During the 1960's, the number

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[1] "The New Rich South: Frontier for Growth" *Business Week* (Sept. 2, 1972) p. 35.

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of chemical workers increased by about one-third; the industry now accounts for more than 6 percent of the total manufacturing work force of the region, ranking behind only such mainstays as textiles, apparel and food processing.

In addition, the South's economy has benefited from a diversification in agriculture that involves a switch from almost total dependence on commodity crops like tobacco and cotton, with volatile prices, to more profitable ventures, such as livestock, poultry and eggs, and dairy products.

In the West growth is expected to continue in the vicinity of Houston and Dallas - Forth Worth and along certain urbanizing corridors following major water routes or mountain fronts:

> Specifically, in the twenty years 1950 to 1970, the Pueblo-Denver-Cheyenne urban chain became 200 miles long, with 13 cities each over 10,000 population, across 9 counties, with hundreds of school, fire, recreation and other districts; increasing in population by 80 percent, while the rest of Colorado and southeast Wyoming grew only 1 percent. The Provo-Logan urban chain became 100 miles long, with 8 cities over 10,000 population. Four counties and many special districts grew by 74 percent, while the average growth of the rest of Utah was only 7 percent. The Albuquerque-Santa Fe chain became 60 miles long, grew by 88 percent while the rest of New Mexico grew by 4 percent. The Boise-Twin Falls urban chain became 60 miles long, grew by 36 percent while the average growth of the rest of Idaho was only 13 percent. The Billings-Great Falls urbaning area grew by 52 percent, while the rest of Montana grew only 7 percent. And the Tucson-Phoenix urban chain, 110 miles long, grew by some 540 percent![1]

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[1] Statement from the Federation of Rocky Mountain States in U.S. House of Representatives. Hearings, op. cit., (1973), p. 585. The Geological Survey of the Department of the Interior, under its Resource and Land (RALI) Program, is currently sponsoring a project in the Tuscon-Phoenix area to study the effects of the gradual transition from an agricultural-recreational economy to a more industrialized one.

Another characteristic of industrial growth is its rural orientation. Again, in the South which is industrializing faster than any other part of the nation, during the 1960's manufacturing jobs increased 61% in the rural counties 50 miles or more from the nearest metropolitan area. The rural counties of South Carolina gained 91.6%.[1] For the nation as a whole rural and partly rural counties added manufacturing jobs at a rate of 4.6% a year in the 1960's - more than double the growth rate of metropolitan areas.[2]

If this trend continues, it may have a significant effect on potential water degradation. About half of the nation's water withdrawals is for industrial purposes, including cooling for power generation. During the sixties it has been estimated that at least 73% of these withdrawals occurred within metropolitan areas. A change in industrial site-location patterns, therefore, is causing greater dispersion into rural areas and the potential impact this may have on water quality is a topic worthy of further investigation.

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[1] "Industry in Rural South Sets U.S. Pace in Growth," New York Times (July 2, 1973), p. 1 & 18.

[2] Cassidy op. cit., p. 7.

3. Land Use and Significant Deterioration

As a result of a major study on the possible impact of the proposed non-degradation regulations on regional development and economic growth, some preliminary conclusions have been reached concerning the growth and land use implications of the four proposals. The four proposals include nationwide ambient air quality increments (Alternative I), emission density limitations for clean air areas (Alternative II), state and local option (Alternative III), and area classification or zoning (Alternative IV).[1]

Under Alternative I, the proposed annual sulfur dioxide (SO_2) and total suspended particulates (TSP) increments appear to be adequate to allow planned and projected economic growth in most urbanizing areas to 1980.[2] Some areas would exceed the proposed increments by 1990 with limitations on future growth after 1990. With careful siting and the use of taller stacks, it was concluded, Alternative I would allow most new major industrial development, although the increment may be violated by large power plants, copper, cement, iron and steel and complexes with associated large-scale mining operations. In Air Quality Control Regions (AQCR's) with sections already above or approaching secondary standards (generally core areas of cities), Alternative I will force industry and development to be dispersed on the fringes (generally suburban and rural areas). Unless public transportation systems respond to this need, it should be noted,the net result may be a substantial increase in automobile-related pollution. In addition, in rural areas with few other emission sources, large industrial emitters must locate at least 10 kilometers from other large emitters to avoid adversely affecting ambient air quality (AAQ).

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[1] The four proposed non-degradation alternatives are as follows:

Alternative I. Maximum allowable increases in air pollution concentrations: particulates, 10 micrograms per cubic meter, annual average; 30 micrograms 24-hour average; sulphur dioxide, 15 micrograms annual average; 100 micrograms, 24-hour average; 300 micrograms, 3-hour average.

Alternative II. Maximum allowable increases in total emissions: particulates, 20 percent increase or three tons per year per square mile; sulphur dioxide, 20 percent increase or 10 tons per year per square mile.

Alternative III. State source-by-source review before construction.

Alternative IV. Maximum allowable increases by zones: Zone 1 - particulates, five micrograms, annual; 15 micrograms, 24 hours; sulphur dioxide, two micrograms, annual; five micrograms, 24 hours; 25 micrograms, three hours. Zone 2 - Particulates, 10 micrograms, annual; 30 micrograms, 24 hours; sulphur dioxide, 15 micrograms, annual; 100 micrograms, 24 hours, 300 micrograms, three hours.

[2] The exceptions include Boston and Dallas-Fort Worth which would be restricted by the secondary TSP standard and two areas in New York State which would violate the increments slightly by 1980.

In the case of Alternative II preliminary findings showed that the impact on regional growth varies widely with the size of the averaging area and the existing emission baseline. Under Alternative II power plants absorb a major portion of the allowable increments in growth areas.[1] This is because on a nationwide basis emissions growth is largely a fossil-fuel based power plant problem. Power plants will be responsible for 84 percent of the particulates and 98 percent of the sulfur oxide increases projected for all the aforementioned 16 industries, together with their major industrial suppliers and markets (i.e., those that are geographically integrated). The restriction of accessible electric power, in turn can be moderate to very restrictive on other types of industrial and commercial development. Under Alternative II, locational factors within the AQCR are not relevant to the question of violation.

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[1] For example, the entire State of Massachusetts could not absorb the growth in power plants projected for just the Boston area, while power plant development in Dallas-Fort Worth and most of New York State would be restricted by 1980.

In the case of Alternative IV, all indications point to the feasibility of maintaining Zone I (pristine area) levels and allowing reasonable and planned growth in adjacent areas with minimal impact on state or regional growth. Zone I essentially restricts any industrial activities in and around the area with the exception of a kraft pulp and paper mill (100,000 tons per year capacity) and a very small, well controlled power plant. For Zone II areas (isolated industrial growth and resource development permitted) an exception scheme will have to be developed to permit the analysis of social economic and environmental tradeoffs in industrial plant siting and sizing, natural resource development (e.g., open pit mining), the collocation of industries, and other factors. Under this alternative urban areas currently at or near secondary standards would have very little growth allowed in those areas in violation but, at State option, surrounding suburban and semi-suburban areas (Zone III) would be more intensively developed. If the exception were not used in some areas, similar impacts as noted for Alternative I may result (i.e., dispersed sprawl development and increased auto-related pollution).

In general, Alternative IV has an advantage in that the zoning approach is compatible with the proposed National Land Use Policy and Planning Act in that it forces the planning of growth in terms of environmental criteria and insures the preservation of pristine areas.

E. Areas of Critical Environmental Concern

The National Land Use Policy and Planning Assistance Act, when approved, will make State designation of "areas of critical environmental concern" a key target for regulation. Development of shoreline sites, wetlands, flood plains and unstable soil zones has proceeded with little or no regard for the environmental consequences. The damage is now readily discernible.

For example, due to extensive development along Long Island Sound, 50 percent of marshes were destroyed between 1914 and 1965. In the decade between 1954 and 1965 Fairfield County lost 45 percent of its remaining tidal wetlands, New Haven 13 percent and Middlesex and New London counties 6 percent and 3 percent respectively. During the period 1954-1964 Nassau and Suffolk Counties lost 8,200 acres of marshland, 24 percent of their 1953 total.[1]

For the nation as a whole, and in spite of extensive dam building, annual damage from floods has gone up to $2 billion a year, as developers continue to move into flood plain areas.[2] EPA has an explicit policy to protect wetlands within the jurisdiction of any of its progress and operations.

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[1] New England River Basins Commission. Long Island Sound Regional Study. (August 1, 1971), pp. 2-11.

[2] CEQ Fourth Annual Report (1973), p. 313

1. The Coastal Zone

In terms of timing for the control of development, the coastal zone represents the most critical problem. Of the nation's 60,000 miles of shoreline (including the Great Lakes), only six percent is owned publicly. Ninety-one percent is under private control and the remaining three percent is restricted for military use.[1] The coastal zone accounts for 15 percent of the nation's land area and houses 33 percent of the U.S. population and 40 percent of the manufacturing enterprises.[2] Specifically EPA is concerned about this development as the effect of growth on shorelines impacts water quality (see Sections 304, 314 and 403 of the Federal Water Pollution Control Act).

Not only is the coastal zone a valuable national resource worthy of preservation in terms of recreation and aesthetics, but, it is also critical ecologically. Coastal wetlands serve as aquifer recharge zones and are vital to highwater absorption following storms or floods.[3] They function as barriers separating subsurface fresh water from ocean water; the mud, sand, and vegetation along the shore act as a buffer to abate the impact of storm driven waves.[1] Coastal wetlands are prime habitats for many wildlife species. Estuaries in particular are of critical concern.

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[1] Papers on National Land Use Policy Issues, op. cit., p. 108

[2] Ibid, p. 163.

[3] New York State Dept. of Environmental Conservation, Environmental Plan for New York State, (1973) p. 67.

At least two-thirds of the animal population in the oceans spend an essential portion of their life cycle in estuarine water or are dependent on species that do. Innumerable waterfowl and shorebirds depend on the plant and animal organisms of the coastal zone for their food. Many winter and nest in these areas.[2]

Development on coastal wetlands disrupts wildlife habitats; dredging, draining and filling activities pollute coastal waters. Sedimentation problems may result, as in the extreme case of Cape May, New Jersey where one fourth of the land area was lost because of erosion over the last 30 years.[3] Stream channel widths may change as a result of dredging and filling, in time altering water velocity and temperature which directly impact the underwater ecosystem.[4]

The competition for remaining shoreline sites is anticipated to continue unabated. Shipping operations, offshore drilling, other industries requiring water for their operations are dependent on access to waterborne transportation. Residential developers particularly the vacation housing market and transportation facilities, notably highways and power plants in search of cooling water, will vie for the remaining available and developable sites.

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[1] *CEQ 4th Annual Report,* p. 311.

[2] U.S. Senate. *Hearings Before the Committee on Interior and Insular Affairs on National Land Use Policy* (July, 1970, Part 2) p. 350.

[3] Papers on National Land Use Policy Issues, *op. cit.*, p. 112.

[4] *Ibid,* p. 20.

Without regulation the coastal zone will be exhausted. The 1972 Coastal Zone Management Act and the Environmental Protection Tax Act are approaching a control strategy, but neither will effectively curtail development in all areas where environmental damages outweigh social and economic considerations. EPA can be effective in protecting such areas through area-wide waste management action (under Section 208) to establish criteria for correcting water quality in coastal zones.

2. Wetlands Other Than Coastal

Though coastal wetlands may be the focus of most publicity, inland wetlands are equally critical to environmental stability. Any policy that might be generated for coastal wetlands should also be applied to interior sites which are vital as aquifer recharge zones and wildlife habitats. Development on inland wetlands is equally as dangerous in terms of sedimentation and disruption of plant and animal life cycles.

3. Floodplains

A flood plain acts as a safety valve which can hold excess water when a rainstorm or melting snow swells a stream above its normal banks. Development in flood plain areas can be hazardous in several ways:

> The stream that had previously overflowed its banks without causing more than minor annoyance has suddenly become a threat to life and property. And, in addition to the danger to the immediate buildings, their presence obstructs the flood flow, increasing the height of flood water upstream and spreading the damage onto land that might not otherwise be affected.[1]

Limiting development on flood plains can be a major factor in preventing and minimizing these problems.

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[1] New York State Department of Environmental Conservation, Environmental Plan (June 1973), p. 49.

Disruption of flood plains can be directly attributed to development:

> The stream that had previously overflowed its banks without causing more than minor annoyance has suddenly become a threat to life and property. And, in addition to the danger to the immediate buildings, their presence obstructs the flood flow, increasing the height of flood water upstream and spreading the damage onto land that might not otherwise be affected.[1]

Flood damages can be minimized and in some cases prevented with proper control measures. Upstream water storage facilities can regulate flow during highwater periods. Runoff may be slowed by small ponds, in-stream barriers and erosion control techniques. Dikes and levees are useful for rerouting excessive flows. It is important, however, to consider the impact of a structural change - a dam, a floodwall, drainage canal - on the water supply and on water levels downstream.[2] Prior to analyzing impacts of flood control measures, it is necessary to define which flood plains are safe and unsafe for building. EPA is authorized under Section 208 to require the area-wide management agency to control development on flood plains and to insure proper land use in these critical areas.

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[1] Environmental Plan for New York State, op. cit. p. 49.

[2] Environmental Plan for New York State, op. cit. p. 50.

4. Unsuitable Soils

The most common problems associated with unsuitable soils derive from development on shallow bedrock or steep slopes. Septic tanks set in shallow bedrock pollute the groundwater supply. The poor internal soil drainage can result in basement flooding. On certain days accumulated water may expand and contract in shallow bedrock damaging foundations after construction.

In contrast to these ground water problems, the damage associated with steep slope construction is surface erosion, gullying, and ultimately landslides which may result on a steep site without proper control measures. Development on slopes is popular because of the scenic views they afford, but people are often not forewarned of the possible dangers associated with such a site.

5. Other Cases

Development should be at least regulated if not prohibited in two additional areas. Lands subject to natural weather disasters such as hurricanes and cyclones should have very limited activities with restrictions on the type of construction methods and materials used. Areas close to seismic faults or active volcanoes should be avoided altogether. Development on earthquake zones may aggravate the subsurface pressure problems by interfering with the earth's normal shock-absorbing capabilities. The high-use development, the extensive road and sidewalk paving in downtown San Francisco, for example, are compounding an already severe problem.

6. Arid and Semiarid Regions

Arid and semiarid regions are characterized by an ecosystem which is in a delicate state of balance. Relatively minor changes in the landscape can result in severe disruptions of the local hydrologic regime and/or increased susceptibility of sand and dust to airborne movement. Environmental problems related to the use of arid and semiarid lands have been of limited importance over the past two decades due to the relatively slow rate of development in such regions. More recently, however, concern over the availability of fossil fuel resources has awaken interest in the exploration and mining of vast areas of these lands.

The shortages of oil and natural gas are shifting the burden of fuel energy supply to coal, particularly low-sulfur content grade, and to oil shale. Deposits of low-sulfur coal are concentrated in Montana, Wyoming, Colorado, and Alaska, while oil shale deposits are predominantly found in Colorado, Utah, and Wyoming.[1]

It is estimated that 192,000 square miles of arid and semiarid land in the western United States is underlain by coal and an additional 17,000 square miles is underlain by oil shale deposits in the Green River Formation.[2]

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[1] See Fuel Mineral Land Use Study in Appendix F (p. 20); and Battelle Laboratories, Environmental Considerations in Future Energy Growth, April 1973, p. 198.

[2] "Western Coal: Does the Debate Follow Irreversible Commitment?" Science (Vol. 1, No. 82, Nov. 2, 1973), p. 456, and Battelle op. cit., p. 198.
Of all 192,000 square miles of coal and lignite in the West, however, only 2250 square miles are thought to be amenable to stripping. Of this, the National Academy of Science panel foresees the actual strip mining for power generation of 140 square miles by 1990 and 300 square miles by the year 2000. (The full acreage that might be stripped for gasification, and liquefaction plants was not estimated.) For comparison, strip mining for coal in the eastern United States has already disturbed nearly 2000 square miles. The disparity between the East and

The adverse impacts of coal and oil shale mining may be aggravated in arid and semiarid regions for the following reasons:

(1) Reclamation processes may require substantial supplies of water to maximize results;

(2) The water requirements of mining itself may significantly alter the supply regime in these areas;

(3) While there is a limited information on western coals, it it known that uranium and other constituents are present which may be of some environmental consequence;

(4) Personnel requirements for new coal and oil shale developments may induce growth in presently sparsely populated areas, resulting in another source of demand on limited water supplies.

A recently completed study by the National Academy of Science has concluded that "while enough water exists in the Western coal fields to fill the relatively meager needs of strip mining itself (and in most cases rehabilitation of the land), there simply is not enough water in the western states to permit the enormous congregations of coal-fired generating, gasification, and liquefaction plants envisioned in recent years by utilities and oil companies."[1] For example in the North Central Power Study (October, 1971) the 25 participating utilities picked 42 sites in five states for coal-fired steam generating plants that would produce 50,000 megawatts

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(cont. from previous page)
West stems from far greater average thickness of near-surface coal beds in the West, and helps to explain why the academy committee found the prospect of huge energy conversion plants more worrisome than mining itself. Judging from the scale of the utility plans, their report said, total acreage disturbed by transmission lines alone might exceed that of mined land.
(Science. Nov. 2, 1973, p. 45-48)

[1] Ibid, p. 456

by the end of the century. (By comparison, the 39 existing coal plants in the western states generate 9300 megawatts.) Three new dams and reservoirs in Montana and Wyoming would provide another 3000 megawatts of pumped-storage hydroelectric power. At peak activity the North Central project would consume 855,000 acre-feet of water a year, equal to more than half of New York City's annual consumption; with gasification and liquefaction plants, annual water demands would rise to 2.6 million acre-feet.[1]

Other findings of the Academy's report were:

- In most Western coal fields, unlike those in the East, near-surface coal seams are also groundwater aquifers serving livestock and domestic wells. Mining operations that cut into such coal-seam aquifers may reduce the flow of water to some distant wells and "dewater" others altogether. Around Gillette, Wyoming, for example, the academy panel said several hundred wells could be impaired by stripping operations some miles away. The panel said it knew of no proven method of patching the gaps in a coal-seam aquifer once the coal is removed.
- Similarly, the panel said, stripping operations that destroy the surface drainage features of a mining site may have serious hydrologic repercussions on the surrounding, unmined area. Ephemeral streams,the dry gullies and arroyos that carry water only after thunderstorms or spring snowmelt,are described as a vital feature of the arid bioscape that must be preserved in mining operations. Eradication of old channels, the panel said, forces the run-off of infrequent but often intense desert storms to cut new channels, thus increasing erosion rates that are already among the nation's highest. Moreover, mining operations that deplete regional water tables trigger a domino-series of damaging effects on surrounding lands. As the water table drops, protective vegetation dies from lack of soil moisture and the land is exposed to more extensive erosion. The end effect, said the panel, could be the destruction of grazing lands in alluvial valleys; this and other off-site side effects are seen as adding potentially major new complications to Western water law.[2]

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[1] Science, November 2, 1973, p. 456.

[2] Ibid.

One area not considered by the Academy study was the implications of the proposed new towns that may be established to provide labor and services for the energy-related facilities.

Arid and semiarid regions may thus experience such intense utilization as to endanger them permanently. It is critical that energy needs be balanced with environmental considerations, and not just superficial ones. The entire range of impacts, primary and secondary, from oil shale and coal mining in the West must be assessed.

F. New Construction

Senator Henry Jackson, as Chairman of the Committee on Interior and Insular Affairs, has stated that "between now and the year 2000, we must build again all that we have built before." "We must build as many homes, schools, and hospitals in the next three decades as we built in the previous three centuries."[1] It has further been estimated that new construction of homes and apartments, schools and hospitals, factories and offices, roads and railroads, shops and parking lots and so forth will cover five million acres, an area the size of New Jersey.[2]

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[1] U.S. Senate. Report on the Land Use Policy and Planning Assistance Act. (Committee on Interior & Insular Affairs, No. 93-197), pp 36-36.

[2] U.S. Senate Committee on Interior & Insular Affairs. Background Papers on National Land Use Policy (April 1972), p. 21.

Regardless of the location of this construction - whether rural, suburban, or urban - the impact on water quality will be a vital concern. For example, erosion from urban and highway construction can range from 1,000 to 150,000 tons per square mile per year, compared to the normal rate in natural areas of 15 to 200 tons per square mile per year.[1] Although construction activity ranks as a relatively less significant source of sedimentation than cropland on a nationwide yield basis, on a local basis it can have quite a substantial impact such as plugging storm sewers and blanketing spawning areas with silt due to its high sediment delivery ratio. For example, one study of the Bel Pre Creek area in Maryland found that when urban construction was increased by 15 percent on a pasture—woodland, storm runoff increased 30 percent and suspended sediment increased 14 percent. In another case, a U.S. Geological Survey study of the Scott Run Basin near Washington revealed that 85 percent of the sediment transported into the basin came from highway construction which covered only 11 percent of the basin area.[2]

The impact of this sediment varies according to the nature and magnitude of pesticides, fertilizers, oils, heavy metal salts and oxides and other construction related chemicals that are carried with sediment either in suspension or as dissolved materials.

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[1] Allan M. Voorhees. Water Quality and Land Use (EPA, May 1973).

[2] U.S. EPA. Non-Point Sources. op cit, pp 246-7.

Major factors responsible for the loss of soil from construction areas include the clearing of large areas of land at one time, rather than in stages. Oftentimes the lack of a well planned grading schedule results in the exposure of surfaces during the heavy rain seasons when the amount of runoff is the greatest.

Most of the pollution associated with construction including both water pollution mentioned previously and air caused by wind erosion of denuded surfaces is well suited to control using existing management techniques. These management techniques include the following:

- For erosion control
    1. Surface roughening (scarcification, tracking, serrated slopes).
    2. Interception and diversion practices (diversion structures - dikes, ditches, terraces or benches; disposal structures - flexible downdrains, sectional downdrains, flumes, and level spreaders).
    3. Vegetative stabilization.
    4. Non-vegetative stabilization (mulches, nettings, structures, and binders).
- For sediment control
    1. Vegetative control practices (buffers, contour strips, sod inlet filters).
    2. Structural control practices (gravel inlet filter, sediment traps and basins, diversion structures).
    3. Specialized sediment control techniques (channel relocation and water treatment).
- For pollutants other than sediment
    1. Good housekeeping (proper use, storage and disposal of pesticides, nutrients, solid waste, chemicals and petrochemicals).

- For stormwater management

  1. Rooftop ponding.
  2. Parking lot ponding.
  3. Local Recreational areas
  4. Diversion structures
  5. Aeration of lawns
  6. Ponds
  7. Porous Pavement
  8. Holding tanks.
  9. Infiltration systems.
  10. Stream channel storage and control
  11. In-line storage in sewers.[1]

There is increasing evidence that more and more contractors and localities are beginning to stress the use of these management techniques.

A factor related to construction and which is of some concern in older inner city areas is the release of asbestos during demolition. It has been roughly estimated that 4000 apartment buildings and 22,000 commercial or industrial buildings are demolished each year.[2]

Although the National Emission Standards for Hazardous Pollutants requires techniques such as wetting and removal of asbestos fireproofing and pipe insulating materials prior to the demolition of buildings or structures to prohibit release of asbestos into the air, it does present a further problem in disposing of solid and liquid asbestos wastes, so as not to pollute other media.

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[1] U.S. EPA. A Report on Processes, Procedures and Methods to Control Pollution Resulting From Construction Activity (HIT - 555 - 1973).

[2] U.S. EPA. Background Information on Development of National Emission Standards for Hazardous Air Pollutants (APTD - 1503, 1973), p. 40.

In addition to construction activity, the nature of the type and design of the construction undertaken can have significant local implications for environmental quality control. The application of well-conceived building standards can serve as a mechanism for assuring that the potential design benefits are incorporated into the preconstruction phase of a project. Examples of design features include insulation to reduce the impact of noise pollution and to conserve energy and the use of buffer zones to reduce noise and air pollution and adverse aesthetic impact. Other examples include designs to smooth or reduce levels of traffic flow, such as are now undergoing review for indirect source regulations. A number of trade-offs must be examined to determine which design method is best. One study has found that with respect to existing buildings being adversely impacted by aircraft noise, the cost of insulating houses would be on about the same order of magnitude as that of land acquisition to create buffer zones.[1] However, both techniques, the report points out, may have associated problems. The creation of buffer zones may result in the dislocation of residences and economic activities, while insulation merely protects people while they are in their houses. The outdoors would still be subject to aircraft noise.

The multi-purpose characteristics of the techniques also needs to be examined. As an illustration, the Office of Emergency Preparedness has estimated that establishing upgraded construction standards and tax incentives and regulations to promote design and construction of energy, efficient dwellings including the use of the "total energy concept" for multi-family dwellings can result in energy savings of 14 percent (5.1 quadrillion BTU per year) by 1980 and a 30 percent savings (15 quadrillion BTU per year) beyond 1980.[2]

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[1] National Bureau of Standards. The Economic Impact of Noise. Prepared for U.S. EPA December 1971, p. 31.

Buffers, on the other hand, can have numerous advantages: natural buffers can help to absorb excess run-off and reduce the level of some types of air pollution; buffers can act as wind breakers, thereby providing some degree of energy conservation; and buffer zones can provide space for land uses that otherwise might consume precious space in some densely populated areas, e.g., cemetaries.

All these trade-offs deserve consideration during both the planning and execution of new construction work.

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[1] Office of Emergency Preparedness, The Potential for Energy Conservation. October 1972, pp 56-57.

III. SITING ISSUES

A. Approach

1. Definition

Approaching land use problems strictly from a land use perspective suffers from numerous complications, the most critical being over-generalization. Introducing specifics such as the quantifiable environmental impacts associated with a land use element such as residential, commercial or industrial development can require a circuitous analysis that may detract from the thrust of a study effort identifying land use issues of EPA concern. Focusing on the siting of key facilities, however, eliminates this intricate linkage process while also affording a precise picture of projected land consumption patterns and the associated regional implications.

Siting issues represent individual, conscious locational decisions both public (e.g., highways) and private (e.g. manufacturing plants). These contrast with the general growth issues discussed in Part II, since the latter is the culmination of a large number of locational decisions either consciously or unconsciously made.

2. Facility Selection

Those facilities selected for siting analysis will account collectively for more than 95 percent of the total incremental adverse environmental impacts associated with the siting of all new facilities over the next 20 years. Furthermore, they incorporate almost all air pollution sources stationary, mobile, or indirect source of any magnitude. Decisions to site these facilities can involve some degree of locational option and hence are potentially subject to land use controls.

The following list identifies the siting issues selected for analysis:

- Airports
- Highways
- Electricity Generation and Transmission Facilities

- Indirect Sources
- Treatment Facilities
- Solid Waste Facilities
- New Source Peformance Standard Industries
- Hazardous Pollutant Sources

B. Methodology

The purpose of an analysis focusing on the siting of key facilities was to identify trends, problem areas, unresolved questions and issues of interest to EPA decision-makers.

Studies (see Appendices B-F) conducted on the siting issues focused on four topics as follows:

(i) What are the current and projected (1985) demand, supply and land use patterns underlying the particular siting problem.

(ii) What are the current and projected environmental impacts, both primary and secondary, of each land use, given the demand projections developed in (i) above and assuming current BACT, existing statutory/regulatory requirements, and present locational considerations and land use practices.

(iii) What possible strategies and methods other than land use controls might be used to abate the adverse environmental impacts identified in (ii)above and to what extent are these strategies and methods likely to be effective. Examples of such strategies and methods include anticipated new technology, changes in operating methods, increased use of less polluting alternatives (e.g., public transit versus auto, rail versus truck, or nuclear versus fossil fuel generation) and the like.

(iv) To what extent are land use/locational controls capable of controlling pollution problems that cannot be dealt with adequately through non-land-use mechanisms.

Based on the data collected in the above four areas, each of the major siting issues studied was screened against a series of criteria and thereupon ranked in terms of relative importance and feasibility of land use controls as a method of assuring environmental quality. The criteria used for this purpose included the following:

--Timing (immediacy and duration of environmental impact; urgency of requirement for EPA action);

--Irreversibility (permanence of environmental impact);

--Present or potential conflicts (with stated national policy; with institutional interests--for example, public authorities such as TVA or local port authorities; with state and local government plans, powers and interests);

--Magnitude of the impact (estimated ecological effects; impact on air quality, water quality, noise; potential costs);

--Extent of the impact (quantity of land involved; urban versus rural locations);

--Extent of chain effect (for example, impact on water cycle).

--Estimated demand for land (for airports, highways, energy facilities, and so on).

Problems identified with one or more of the above criteria or in the body of each analysis were translated into sub-issues for EPA perusal.

C. Siting Issues by Type of Facility

The purpose of this section is to highlight the findings of a series of case studies conducted by Harbridge House, Inc., on the siting of key facilities. Some of the case studies have been included as appendices to this report. Other studies which have greater significance at the regional or local level (e.g., various industrial and non-fuel mineral analyses) have not been included, but are available in the form of working memoranda from the EPA Office of Planning and Evaluation.

The discussion of each siting topic is divided into two parts. The first part highlights trends in the number of facilities to be sited, important locational forces and differential regional impacts. The second part presents a list of siting issues for each type of facility. These issues are either questions related to policy and priority which may be of significance to EPA or are questions that require further study and analysis in order for EPA to adopt a position with regard to them.

1. Airport Siting

a. Trends

The Federal Aviation Administration (FAA) estimates that passenger-miles traveled will double by 1980 and almost triple by 1990. The number of take-offs and landings, however, is projected to increase at a faster rate than the number of passengers enplaned, indicating the use of larger planes with greater carrying capacity will not have as much impact as the rapid increase in the use of small private planes (FAA projects a 63 percent growth in enplaned passengers over the next five years versus a 73 percent increase in aircraft operations).

FAA allocation of Airport Development and Airport Planning Funds is based on the highest priority being assigned to expanding and/or removing operational restrictions on hub or reliever airports serving major metropolitan areas by:

- Enlarging hub airport capacity to handle more scheduled flights either through the construction of parallel runways (to handle more planes) or extension and strengthening of runways (to handle larger planes).
- Development of separate general aviation runways at hub airports to handle taxi and feeder service (increases the capacity of existing commercial runways and generally requires less land consumption than parallel runways).
- Convert general aviation airports to reliever airports principally through better instrumentation and/or runway extension (permits the diversion of short haul traffic away from hub airports).

This FAA priority means that the focus of environmental and land use problems will coincide with existing problem areas, especially in the Northeast Corridor and Chicago's five corridors.

In addition to the impact of aircraft operations and vehicular traffic carrying passengers, employees, and visitors, airports are a force in attracting certain types of commercial and industrial developments. Some efforts have already been made to control growth around hub airports. The control of development in conjunction with reliever airports, however, will probably prove to be more difficult, in part because of the geographic dispersion of these facilities and in part because many represent upgrading of existing general aviation airports, so that siting *per se* is not an open issue.

b. Issues

(1) What is the differential impact of constructing a few select major hub-airports versus the expansion of a large number of reliever airports?

(2) What is the nature and extent of the environmental impact relating to secondary (induced) growth by size and type of airport?

(3) What is the potential application for multi-use airport buffer zones to accomplish environmental improvement?

(4) Since there is evidence that development is clustering around reliever airports, is it advisable for EPA to change its proposed indirect source review to include more airports than just those falling within the 50,000 or more annual commercial operations category?

(5) What position should EPA take with regard to resolving the conflict between airport siting in urban areas in accordance with a non-degradation policy and semi-rural or rural siting to abate noise pollution?

2. Highway Siting

a. Trends

The Federal Highway Administration (FHWA) estimates that over the next 20 years (1970 - 1990) travel will continue to grow at an average annual rate of 4.2 percent (this represents almost a two-thirds increase in annual vehicle-miles traveled between 1970 and 1990). Based on the growth projection FHWA estimates that over 60.2 percent of all vehicle-miles of travel will be within urban areas by 1990 (versus 52 percent in 1968). To meet the needs forecast, FHWA has calculated that the optimal national economical investment in new roadways should be increased by 52 percent over the 1970 investment level and further:

--that the largest increase, 63 percent, should be in small urban areas;

--rural areas should have the smallest increase or 36 percent.

By 1990 it is projected by FHWA that 20.8 percent of street and highway miles will be in urban areas versus 13.7 percent in 1968. Part of the increase is due to urban sprawl extending the urbanized land area from 1.3 percent to 2.5 percent of the total. If FHWA's highway construction program continues on schedule, by 1990 an area approximately the size of West Virginia will be consumed for new road networks.

FHWA assigns the greatest concentration of needs to the Northeast Corridor which accounts for approximately 25 percent of the nation's total vehicle-miles on less than 2 percent of the nation's land. Other areas scheduled for heavy investment to meet projected demand are California, Texas, Illinois and Ohio.

There is evidence that the impact of highways in inducing growth and facilitating a dispersed population pattern is especially strong in suburban areas. This type of pattern, in turn, limits the ability of an area to encourage public transit and carpooling transportation alternatives.

b. Issues

(1) What are the possible environmental and land use effects of the proposed DOT highway construction program? What role should EPA play in it, other than simply reviewing EIS's for proposed new segments?

(2) What is the probable nature and magnitude of highway routing decisions to induce development and dispersed population patterns, especially in suburban areas?

(3) What will be the environmental consequences (especially with regard to diverting or inducing traffic) of completing the Interstate Highway System, the remaining segments being largely within major metropolitan areas?

(4) What kind of environmental controls - either supplementing or complementing land use controls - will assist in directing the nature and intensity of development at interchanges?

(5) What controls are necessary to reduce adverse environmental impacts associated with highway construction

- for different levels of development (urban, suburban, rural)?
- for type of construction materials (asphalt vs. concrete)?

(6) What are the intermedia trade-offs between elevating and depressing highways?

(7) How compatable are indirect source and other EPA regulations with inducing growth patterns compatable with public transit?

(8) What position should EPA take on the proposals to provide operating subsidies for public transit systems?

3. Wastewater Treatment Facilities

a. Trends

Municipal wastewaters in the United States average by volume about 55 percent from domestic - commercial sources and 45 percent from industrial sources. It is estimated that each year about 1,000 communities outgrow their treatment facilities, resulting in large amounts of raw or inadequately treated sewage flowing into waterways.

Only about two -thirds of the U.S. population is presently served by sewerage systems, with the rest relying on disposal using septic tanks and cesspools which are capable of producing localized water pollution problems. There also appears to be some evidence that wastewater treatment facilities can induce growth or serve as a prime determinant in channeling the direction of new development. Based on the number of construction projects required, California, Illinois and Pennsylvania have the greatest need for new or expanded facilities.

b. Issues

(1) What are the factors that magnify the importance of the effect waste water systems have on the nature and direction of growth?

(a) Do the relatively low capital and operating costs for sewage collection and treatment as a proportion of total community infrastructure costs make it easier for this type of investment decision to be reached by localities?

(b) To what extent is it true, at the present time, that the existence or feasibility of sewerage and water treatment has been the principal factor leading to decisions on whether an area should be rezoned for development or whether a subdivision should be permitted?

(c) To what extent does the financing of systems through the levying of user charges, connection fees, and other taxes result in enlarging the service area as a means of increasing revenue, rather than as a response to existing needs?

(d) Are EPA programs which emphasize regional systems encouraging some areas to design systems larger than required - based on projected demand - in order to obtain EPA funding and without understanding their implications for growth?

(2) Should grant allocations for wastewater treatment facilities emphasize upgrading older systems or building new ones?

(3) When and where should sewer moratoria be evoked to preserve water quality?

(4) What is the impact of construction grants for wastewater treatment facilities in inducing growth and increasing demand for still more facilities?

(5) Should growth induced by treatment facilities be controlled through the application of design capacity constraints, land use controls, or some combination of the two?

(6) What type of sewerage system would best serve an urban fringe area where growth is just beginning to occur (regional versus small package plants)?

(7) What requirements, if any, are needed to control the use of septic tanks within particular areas?

(8) What are the land use implications of alternative means of sludge disposal?

4. Landfill

a. Trends

Projections for the generation of solid wastes indicate tremendous growth. It is estimated that per capita consumption will increase from 5 pounds in 1970 to 8 pounds in 1980, while the total quantity of collected wastes will double between 1973 and 2000. In terms of disposal systems for urban solid waste, only 13 percent is disposed in sanitary landfill. Of the remaining waste generated, 77 percent goes to open dumps, 8 percent to municipal incinerators and 2 percent to ocean dumping, composting, hog feeding, or salvage operations. Of the systems being used, 94 percent of all land disposal operations were deemed substandard by the U.S. Department of Health, Education and Welfare (HEW) in 1970. Seventy-five percent of all incinerator facilities also failed to meet HEW standards. Areas that face critical problems in solid waste disposal - due to large concentrations of population and limited land available for sanitary fill - include Greater New York, parts of California and metropolitan Chicago.

Disposal of hazardous wastes poses a special problem. A 1973 survey found that the disposal of approximately 75 percent of the hazardous wastes was improperly managed. About a quarter of all hazardous wastes are disposed of using landfill sites.

Land for open dumps and sanitary landfills was consumed in 1973 at a rate of 74 acres per day or 27,019 acres per year. It is estimated that by the year 2000 the rate will have increased to 148 acres per day or 54,020 acres per year. Sanitary landfills alone require one acre per year for each 10,000 persons.

b. Issues

(1) What role if any should EPA play in encouraging different approaches to landfill and do regional versus local management of solid waste disposal make a difference in the type of approach that can be used?

(2) To what extent are current governmental regulations on incineration and ocean dumping forcing a change to landfill operations in areas severely restricted with regard to the availability of space for such a purpose?

(3) Assuming relaxed solid waste transport regulations, can solid waste generated in urban areas be used feasibly for land reclamation at mining sites or for fertilizer on agricultural lands? How widespread would such a program be, if practical?

(4) What is the validity of proposed multi-use options for land fill sites in terms of timing, economics, and environmental concerns?

5. Industrial Siting

a. Trends

Industrial siting decisions in recent years have shown a strong tendency to focus on the South and West, as well as a trend to locate in rural as opposed to urban areas. Among the industries currently falling under New Source Performance Standards there is a particularly large degree of geographic concentration of planned new facilities in the southern states. Between 1973 and 1980 approximately half of the Portland cement expansion, half the iron and steel expansion, 80 percent of the sulfuric acid expansion, half the petroleum refining capacity, half the nitric acid capacity, a third of the asphalt concrete batching capacity, half the petroleum storage vessel capacity, and approximately 40 percent of the fossil fuel power plant capacity will be located in this region.

The second pattern that emerges is that many of the new facilities will be located along waterways and coastal zones. This pattern is the result of the large industrial water requirements of some activities and/or the need for relatively inexpensive waterborne transportation for moving high bulk, low value raw materials. Due to the large site-size requirements of several of these facilities, this locational trend is likely to create some serious conflicts with other land uses which gravitate towards waterways and coastal zone sites. The magnitude of the potential conflicts will be further increased by the tendency of some industries to cluster into integrated complexes.

b. Issues

(1) What impact are environmental regulations having on the urban-suburban shift of industrial activity?

(2) In terms of environmental impact, is it better to site industry separately or in complexes and industrial parks?

(3) How severe are the regional consequences for EPA regulations that

-affect one product more than its substitute (Portland cement plants fall under both NSPS and non-degradation control; asphalt concrete plants are only subject to non-degradation)?

-affect more than one link in a manufacturing process (lime manufacturing is subject to non-degradation control; iron and steel mills fall under both non-degradation and NSPS)?

-affect manufacture of a by-product but not the main product itself (sulfuric acid plants fall under NSPS, but copper smelters and phosphate fertilizer plants do not)?

(4) What type of regional analysis should be used to provide some forewarning of trends which may result in regional shifts in pollution problems?

(5) When will resource recovery be feasible, technologically and economically? How widespread could its application be? What will its impact be on the location of industrial facilities using the recovered materials?

(6) Will the trend towards industrialization of rural areas act as a more important factor than highways, airports and other facilities in dispersing population and increasing automotive travel?

6. Energy Facilities

a. Trends

(1) The Electrical Sector

The electrical sector is characterized by the fastest growing demand for energy inputs. The U.S. Department of Interior (DOI) projects that installed generating capacity will experience an average annual growth rate of 5.8 percent between 1971 and 2000. Energy and material shortfalls, however, may result in a lower growth rate, especially over the next five years.

With regard to fuel inputs to the sector, coal has and will continue to be a major source of energy for conversion to electricity. Recent shortages in petroleum supplies have helped to focus attention on the large coal reserves in North Dakota, Montana, Wyoming, Colorado, and Utah, as well as providing a stimulus to plans for mine-mouth siting of power plants in conjunction with coal mining operations.

The industry will also become much more heavily dependent on nuclear power in the future. DOI projects that nuclear capacity will increase its share from the present 2.4 percent to 51.1 percent in 2000. The combined effect of delays in construction of nuclear power plants, technical problems such as emergency core cooling, and public concern over siting may reduce the probability that this projection will be achieved.

The siting problems associated with this sector are numerous and almost all areas of the country will feel some impact over the next 10 years or so. The traditional tendency to locate as close as possible to the load has been reversed in recent years, as the site-size requirements have grown due to economies of scale and the need for space for cooling ponds, storage facilities, disposal pits, and so forth. The dispersion pattern has been strengthened by trends to develop energy complexes where facilities are developed in association with a coal mine or coal cleaning/gasification plant or in association with a petroleum refinery and petrochemical plant.

(2) Petroleum Refineries

On January 1, 1972 there were 250 refineries operating in the United States, accounting for an average operating capacity of 13,034,818 b/d (barrels per day). By December 1973, formal plans had been announced to construct 20 new refineries, resulting in an estimated 1.7 million b/d increase in capacity by 1977. Tentative plans have also been made for constructing an additional 10 new plants, plus four expansions between now and

1980. The major portion of the new construction will be in the States of Texas, New Jersey, and California.

In 1985 for an average size refinery with approximately 200,000 b/d capacity, a site of from 1,000 to 1,200 acres will be needed. If an associated petrochemical complexes is included, an additional 300 to 350 acres may be required. Coastal sites will continue to be attractive due to the locational drawing force of metropolitan markets and because such sites offer greater flexibility in attaining alternative sources of crude, including supplies from the outer continental shelf.

b. Issues

(1) What is the optimal mix (in terms of size, regional distribution and type) of power generating sources with regard to probable differential impact on air pollution and non-degradation strategies?

(2) Where should power generating sources be located?

-urban vs. rural (i.e., load center vs. access to fuel resource as in mine-mouth siting)

-inland vs. coastal

-onshore vs. offshore

-above ground vs. underground

(3) Energy complexes (e.g., deepwater ports, petroleum refineries, power plants, petrochemical operations) have been identified as a future option; utility complexes incorporating solid waste disposal systems and power generating units and other municipal facilities are also being discussed. At what point will such installations be feasible and what will be the environmental implications of such complexes?

(4) What impact will the energy crisis have on the rate and location of new construction of fossil-fuel fired power plants?

(5) Could an energy conservation program reduce the need for new powerplant construction?

(6) Is the land area available to meet requirements for powerplant thermal pollution?

(7) What will be the potential problems in water quantity and quality created by the joint requirements of grazing and energy-related activities in semi-arid areas?

D. Siting Issues by Type of Environmental Impact

Environmental and land use implications of siting specific types of facilities are covered in detail, either under the case studies in Appendices B - F or in Part III, Section C of this report. Consequently, this section attempts to provide a different perspective by discussing the impact of siting the various types of facilities analyzed in terms of the media concerned.

1. Air Pollution

Emissions over the next two decades from fossil-fuel fired power plants and mobile sources will present significant environmental control problems. In terms of projected growth rates for these two sources of air pollution, FHWA estimated that between 1970 and 1990 vehicle-miles traveled will continue to grow at an average annual rate of 4.2 percent, representing almost a two-thirds increase in annual vehicle-miles traveled over this period. To meet the forecasted needs, FHWA has calculated that the optimal national economical investment in new roadways should be increased by 52 percent over the 1970 investment level. Over the near-term at least these projections will not be met. Due to recent rising prices and gasoline shortages, many areas are experiencing an 8 percent or more decrease in vehicle-miles traveled.[1] It has also been announced that highway construction will probably experience a severe drop in 1974 primarily because of material and fuel shortages and an anticipated loss to state and Federal highway programs of some $3.3 billion in fuel tax revenues due to lower consumption.[2]

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[1] Telephone conversation with members of New York State Department of Transportation, January, 1974.

[2] "Land and the Environment", January 11, 1974, p. 1.

For the electrical sector, on the other hand, it is projected that installed generating capacity will rise from 367,395 megawatts (MW) to 1,880,000 MW for an average annual growth rate of 5.8 percent. For fossil fuel burning plants this means more than doubling installed generating capacity from 302,810 MW in 1971 to 720,000 by the year 2000.[1] In contrast to the automotive/highway situation, the so-called "energy crisis" will only serve to spur increased rates of construction.

The delay in the highway construction program as mentioned above, the retrofitting of vehicles with pollution control devices, the adoption of air quality implementation plan transportation control strategies, and the recent pronounced trend towards smaller cars will all help to ease the impact of air pollution from mobile sources. Still, claims by automobile manufacturers of difficulties in meeting retrofitting standards raise some questions as to levels of effectiveness to be achieved, expecially over the next 10 years.

Two types of development will probably remain very sensitive to mobile source pollution. These are the final segments of the Interstate network and complex source facilities. In the first instance, although the Interstate system is largely complete, there are some sections which have been the subject of much debate. Especially within EPA Regions I, II, and III there are segments within or around major metropolitan areas that deserve very careful evaluation in terms of siting alternatives and their impact on environmental quality in Priority I areas. It is this combination of regions that contains the Northeast Corridor. This accounts for more than 25 percent of the nation's total vehicle-miles on less than 2 percent of the nation's land. In addition, of the major Interstate Highway route controversies, 7 of the 11 problem areas within major cities and four-fifths of the disputed route miles are located in the Northeast Corridor.

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[1] U.S. Department of the Interior, U.S. Energy Through the Year 2000, (Government Printing Office, December, 1972), p. 19.

In the second case - that of siting indirect source facilities - the locational patterns have been previously described in Part II. Generally, the areas impacted will be cities of heavy population concentration and regions experiencing strong growth. Much of the new development of indirect source facilities will be on the edges of urban areas, generally following the course of FHWA plans for new construction. Under the construction program approximately 63 percent of new investment is to go into small urban centers within larger metropolitan regions. This will permit cities to expand in such a way, the U.S. Department of Transportation estimates, that by 1990 approximately 18,000 miles of new freeways and expressways will be needed within the boundaries of urbanized areas, compared with about 8,000 miles in 1968.[1]

In the case of fossil-fueled power plants, pollution control also presents a serious problem. As presently operated, central-station power plants have no control over SO_2 emission other than by selection of fuels, and recent energy shortages have resulted in increased demand by power companies to revert to higher sulfur-content fuel. Likewise NO_x is uncontrolled. Particulate matter can be removed from stack gases at rates of efficiencies of up to 99 percent.[2] Nevertheless, "the electrostatic precipitators required for such good performance fail with low-sulfur coal because the electrical resistivity of the fly ash then becomes excessively high".[1] The result is collection efficiencies of 50 percent or less. As a consequence of the state of technology in controlling emission from these sources, it is estimated that 84 percent of the increase in SO_x over the next decade will be attributable to fossil fuel generating plants.

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[1] Reilly, op. cit., p. 82.

[2] The only other paths open to reduce SO_2 emissions are to desulfurize flue gas, to devise wholly new methods to remove sulfur from coal to convert coal into sulfur free liquid or gaseous fuels, or to develop other systems for converting the chemical energy in fuels into electricity. With regard to stack gas cleaning processes that may be applied during 1975 to 1990, Battelle (December 1973) projects that SO_2 removal efficiencies of 75-90% may be achieved over this period.

The locations of very large fossil fuel generating stations is shown in the map in Part II. EPA Regions V, VI, and VII will face major problems in this respect. However, as discussed in the Section on Nondegradation many other parts of the country may also face some restrictions on their ability to meet demand for electricity and maintain AAQ standards.

Finally, there are a few regions that face special types of air pollution problems. Region X, for example, is the proposed site of a number of new and expanded aluminum plants, while New Mexico has a large number of proposed copper smelter expansions scheduled. In both cases control is difficult and restrictions may be imposed on both the rate and size of facilities permitted.

2. Water Pollution

Although every part of the nation has some water pollution, it is more severe in some areas than in others, as illustrated by the map on water quality found in Part II. In 1971, almost twice as many polluted stream-miles were east of the Mississippi River as were west of it. The Ohio, Great Lakes, and Southeastern river basins contain 24 percent of the nation's stream-miles and 49 percent of the polluted stream-miles. To a large extent this configuration conforms to the distribution of population and industry, which together account for approximately 45 percent of all water pollutions from both man-related and natural causes.

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[1] Battelle, op. cit., p. 386

Different types of land use have different relative impacts on water quality. Industry discharges the largest volume and the most toxic of pollutants. Organic effluents from industrial operations, moreover, are estimated to have a pollution strength of three to four times greater than the domestic sewage handled by all municipalities.[1]

In addition to inorganic and organic waste, industry is also the major source of thermal pollution. Although several categories of manufacturers use cooling water for in-house power production or manufacturing processes, steam electric power plants account for about 80 percent of all water withdrawn for cooling purposes and, therefore, is the major source of this type of water pollution.

Implementation of the Federal Water Pollution Control Act Amendments of 1972 will help to curtail many point-source effluents by requiring:

- By July 1, 1977, application of the best practicable control technology currently available.
- By July 1, 1983, application of the best available technology economically achievable.

The amendments specify that applying the best available technology should help to achieve the national goal of eliminating the discharge of all pollutants into navigable waters by 1985.

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[1] U.S. Government Accounting Office. Research and Demonstration Programs to Achieve Water Quality Goals, (January, 1974), p. 15.

EPA has been involved in a number of projects to help develop effective control technology. In the Great Lakes Basin which contains almost 50 percent of the nation's steel-manufacturing capacity and high proportions of the nation's capacity for refining petroleum and chemicals, paper, and food manufacturing, two states have been widely applying some of this improved technology for treating industrial wastes.

Exhibit XIII shows the distribution of stream pollution from various sources by region. The chart shows the Southeast as the leading source of industrial water pollution. This is especially noteworthy in view of the industrial location trends, discussed in Part II, which indicate that the Southeast region will be the major area of new industrial development over the next ten years.

Exhibit XIII

Prime causes in descending rank	Percent of stream pollution						
	United States	Pacific Coast	Northern plains	Southern plains	Southeast	Central	Northeast
Industrial wastes	23.7	12.7	21.0	9.2	34.7	21.5	33.5
Municipal wastes	21.8	13.0	15.6	14.2	21.2	28.5	27.1
Agriculture	11.2	19.1	28.8	27.6	1.3	5.8	.5
Other (note a)	3.7	11.8	.6	16.6	1.7	.4	-
Mining	2.8	2.4	2.6	12.6	.3	4.9	2.6
Other urban wastes	.9	-	-	.1	.7	1.9	1.3
Power generation	.4	1.5	-	-	.6	.6	.1
Spills	.1	-	-	-	-	.2	-
Total	64.6	60.5	68.6	70.3	60.5	63.3	65.1

[a] Divided into three principal classes: water management in highly regulated streams of the West; promotion of sedimentation by construction; and transportation, principally navigation, including stream dredging.

Source: "The Cost of Clean Water," EPA's 1971 report.

In contrast to the progress being made in controlling organic and inorganic effluents from industry, the control of thermal pollution remains a more intractable problem. Sections 301 and 306 of the Federal Water Pollution Control Act require establishment of technology-based effluent limitations for existing and new point sources of thermal discharges. Such effluent limitations will provide the basic thermal pollution control requirements to be met by thermal dischargers, unless more stringent requirements are established pursuant to Section 303, or less stringent requirements are permitted under Section 316.

Several alternatives exist for a facility requiring thermal cooling technology. Cooling ponds, channels or lakes are one type of option. The land requirement for these systems, however, are very significant as shown in Exhibit XIV. A number of multi-use possibilities are being explored to help redeem the commitment of large amounts of land to thermal cooling. Examples of multi-use efforts include the use of waste heat for irrigation, growing commercially valuable fish and shellfish, desalinization, sewage sludge drying, heating new towns, and so forth.

Exhibit XIV

Projected Acreage Requirements of Cooling Systems for 1000 MW Power Plants

	Coal-Fired	Nuclear Plant
Wet Cooling Tower	4 - 5 acres	6 - 8 acres
Dry Cooling Tower	9 acres	16 acres
Cooling Pond	1,190 acres	2,000 acres

Source: Teknekron, Berkeley, California.

Cooling towers are another alternative which while safeguarding water quality have certain secondary impacts, making them incompatible with other land uses. Among these impacts are "drift"(air pollutants in the form of small droplets which are composed of chemicals and dissolved solids), weather modification such as fog creation (especially important in the East) noise, consumptive use of water (important where water is a scarce resource), and aesthetic impact.

Consequently, thermal pollution remains a significant problem. Each year power-generating plants, both fossil-fueled and nuclear, use about 40 trillion gallons of water, or about 10 percent of the nation's entire river and stream-flow, for cooling. Because of the constantly increasing demand for power, the potential for thermal pollution is expected to increase nearly ninefold by the year 2000.[1] Further aggrevating the problem is the attractiveness of waterfront sites for power plants because of the availability of cooling water, the low cost means of transporting fuel, and the possibility - with favorable wind and other meteorlogical patterns that air pollution is dispersed over the water.

With respect to water pollution from urban land, municipal wastes contain large amounts of organic materials, dissolved minerals, and often residues from industrial wastes handled by municipal treatment plants. It is estimated that each year about 1,000 communities outgrow their treatment facilities, resulting in large amounts of raw or inadequately treated sewage flowing into waterways. The question of whether to invest limited federal funds in upgrading existing wastewater treatment facilities or building new ones has already been raised in Part II. The issue of the impact of sewage systems on growth patterns was also raised in that section of the report.

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[1] U.S. GAO, op. cit. p. 5.

It is projected that waste loads entering municipal sewage systems are expected to increase nearly four times in the next 50 years as a result of increasing populations and the continued movement of rural population to urban areas. Compounding the problem of increasing numbers of people within urban areas is the difficulty of handling combined sewers and storm water discharges. The Association of Metropolitan Sewerage Agencies estimates the combined sewer discharges causes 40 - 50 percent of the pollution in all waterways in metropolitan areas. Discharges from combined sewers are a major source of water pollution primarily in the Northeast and Midwest. One of the alternatives for handling combined sewer overflow is to channel the overflow into large storage tanks for later treatment. The difficulty with this procedure is that it is land consuming, creating another potential source of conflict over land use allocation within densely populated areas.

Still another problem vis-a-vis water quality and urban land use, is that the ever-expanding metropolitan boundaries mean a continuous increase in the amount of land covered by asphalt and concrete. A typical suburban municipality will have 30 percent of its land consumed by asphalt, another 30 percent by homes and buildings; the remaining 40 percent would be devoted to lawn and open space.[1] Peak discharges of runoff are known to increase 75 percent when half the land is rendered impervious to water. Urban watershed areas with 80 percent of the soil surface covered or graded that are serviced by storm drains are known to experience peak discharge six times greater than original rates.[1]

---

[1] Charles E. Little, Challenge of the Land, p. 13.

While urban runoff is a major source of water pollution, the forces that created the runoff problem - paving of roadways, parking lots, runways, building construction - are disrupting the vital natural process of aquifer recharge. Without aquifer recharge the groundwater supply cannot be maintained. Consequently, tying siting decisions into the boundaries of aquifer recharge areas and the use of planned unit or cluster development become important considerations in protecting the quality of the environment.

Other types of nonpoint source pollution come from agriculture, silviculture, mining and construction activities. Agriculture and silviculture alone account for 75 percent of the national sedimentation problem; both are also significant contributors to eutrophication and toxic wastes through runoff containing pesticides, herbicides, fertilizer, and animal waste. Although agriculture and silviculture land uses per se are not considered siting issues, the placement of buffer zones, as an effective means of controlling runoff, is the result of a conscious individual decision. Likewise, in the case of mining, siting issues arise in selecting land suitable for reclamation. Decisions related to the nature of the use of the land after conversion, when the mine site is exhausted is a similar siting related choice. Areas selected for construction activities also have to be carefully checked for topographic, soil stability, hydrologic, and other factors to ensure that appropriate control measures (as described in Part II) are adopted.

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[1] Soil Conservation XXXV, no. 4, p. 84.

The Federal Water Pollution Control Act calls for evaluating - as part of the planning process - nonpoint sources affecting water quality. In addition, EPA is in the process of issuing general guidelines for control of nonpoint sources. In connection with this, there are some issues in terms of the economic costs of instituting control measures (e.g., in the case of small versus large farms) and the nature of the institutional mechanism that will ensure the guidelines are implemented. There is a further issue related to the trends in shifting land use by different types of nonpoint sources as discussed in Part II and how to structure the guidelines to take into account such changes.

3. Noise

The most critical source of noise pollution is jet aircraft. A jet plane taking off nearby can attain a decibel level of 150, far above the annoyance threshold of 80 decibels. Traffic too is a significant noise problem. Motorists in city traffic will be exposed to sound levels of 90 decibels; an automobile horn can push the measurement up to 120. Normal freeway traffic, however, falls within the safe zone of 70 decibels.[1] Trucks, buses, and motorcycles are the worst offenders and are known to exceed ambient sound levels.

In the case of aircraft noise, DOT-NASA estimates that in 1978, 1,800 square miles of land area encompassing 24 million people will be exposed to undesirable levels of aircraft noise.[2] (See Exhibit XV) **This is due to increased rates of development around existing airports as well as the impact of new airports (as described in Appendix B).**
Buffer zones are often cited as a means of reducing the noise impact;

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[1] Laurent Hodges, Environmental Pollution, 1973, p. 116.

[2] The National Bureau of Standards, The Economic Impact of Noise, 1971, p. 9.

SELECTED CITIES WITH SIGNIFICANT AIRCRAFT NOISE PROBLEMS

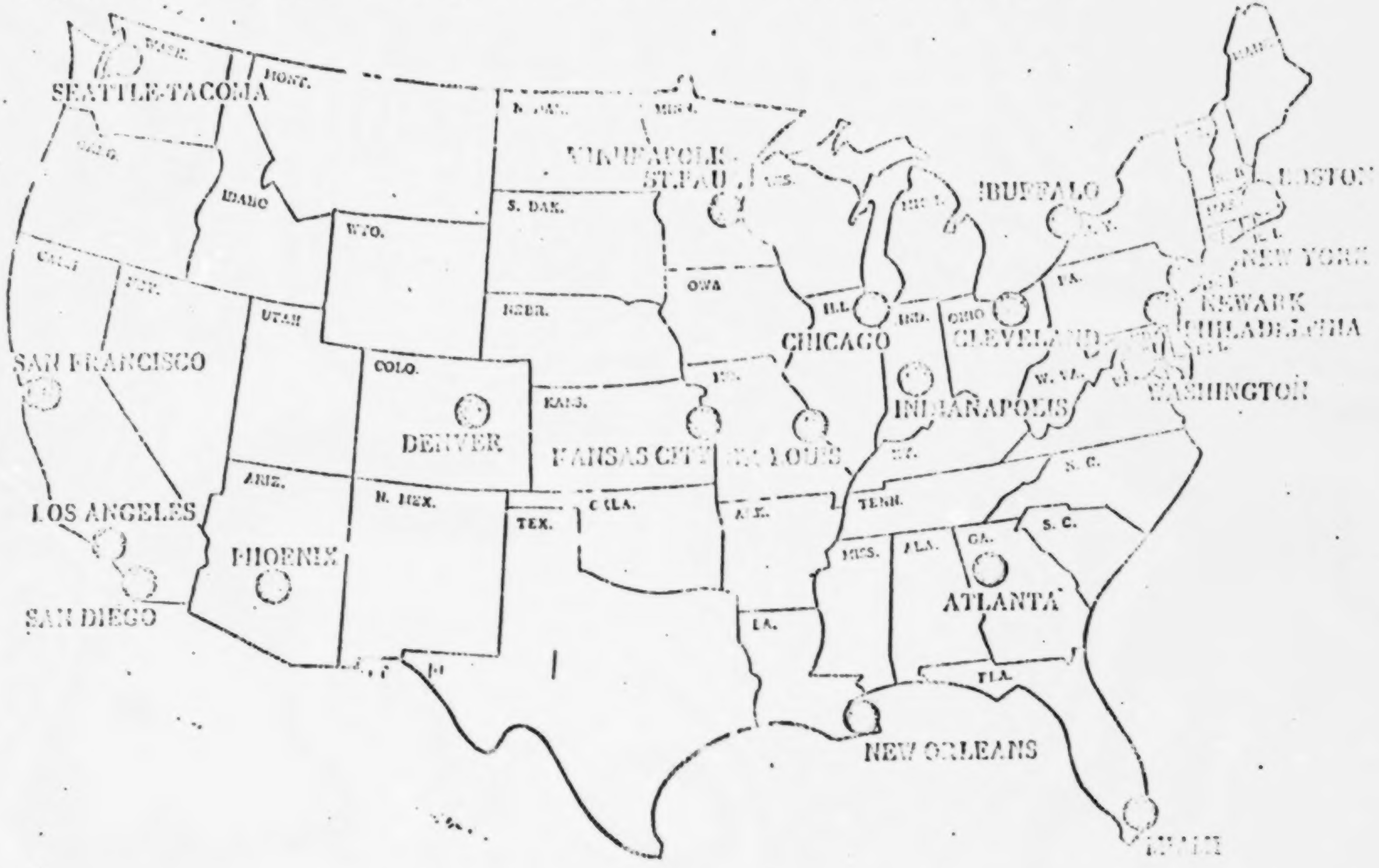
SEATTLE-TACOMA
WASH.
MONT.
N. DAK.
MINN.
MINNEAPOLIS-ST. PAUL
ORE.
IDAHO
S. DAK.
WYO.
BUFFALO
N.Y.
BOSTON
NEW YORK
NEWARK
PHILADELPHIA
WASHINGTON
CALIF.
NEV.
UTAH
NEBR.
IOWA
ILL.
IND.
OHIO
PA.
CHICAGO
CLEVELAND
SAN FRANCISCO
COLO.
KANS.
MO.
W. VA.
INDIANAPOLIS
DENVER
KANSAS CITY
ST. LOUIS
KY.
N. C.
LOS ANGELES
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
S. C.
MISS.
ALA.
GA.
PHOENIX
SAN DIEGO
ATLANTA
LA.
FLA.
NEW ORLEANS
MIAMI

Exhibit XV

however, even with the 25,000 acre buffer zone allotment for the new Dallas/Fort Worth Airport, concern over noise problems is still being raised.[1] Another solution is to site airports at distances fairly remote from residential centers - an idea that is gaining re-enforcement from the lack of available land near areas of concentrated population. Still, the further an airport is removed the greater the automobile travel requirements to reach it, thereby creating an intermedia conflict.

Magnitudes of noise pollution from ground transportation sources have yet to be adequately quantified. Growth rates for motorcycles alone approach 17 percent on a per annum basis; buses and trucks have been growing at an annual rate of 4.2 percent.[2] Automobile registrations are rising annually 4 percent. These statistics placed in the context of a tripling of freeway and expressway highway miles in urban areas between 1968 and 1990 designate a problem area demanding immediate analysis and control strategy design.[3]

4. Solid Wastes

Agriculture and mining are by far the most significant contributors to the solid waste problem accounting for 58 percent and 31 percent (by weight) respectively of total wastes generated. Farm animal wastes alone represent 41 percent of national annual waste production.[4] Improper handling of wastes from both agricultural and mining sources has impaired both air and water quality, especially water through sedimentation and introduction of toxic materials to water bodies. Effective control strategies are difficult to implement, however, because the geographical dispersion of these activities makes collection difficult.

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[1] *Idem*.

[2] *The Economic Impact of Noise*, *op. cit*., p. 37.

[3] See Highway Siting, p. 3.

[4] Hodges, *op. cit*., p. 213.

The solid waste disposal problem from urban and industrial sources derives from the geographic mis-matching of generation sources and disposal sites. Regional as opposed to local administration of disposal systems would improve efficiency by encouraging larger, more economic operations; also attempts to ease transport prohibitions and constraints on solid wastes would have more thrust coming from regional as opposed to local sources. Depending upon the nature of the facility, however, there may be some trade-offs in terms of impact on air quality aesthetics. A region-wide approach may also induce growth in the area, especially industrial, so that siting decisions should be made carefully.

Two other aspects of industrial solid waste disposal deserve consideration. First, Exhibit XVI shows projected requirements for radioactive waste disposal up to 1990. Appropriate burial sites for such wastes need to be selected with a view to avoiding future conflicts in land use. The second issue relates to focusing attention on the measures needed to control ocean dumping of solid waste resulting from the increasing concentration of industries along the coast.

Exhibit XVI

SUMMARY OF RADIOACTIVE WASTE

	1975	1980	1985	1990
Amount, cu ft	1.5×10^6	2.9×10^6	5×10^6	10×10^6
Activity, curies	5.7×10^6	1.3×10^9	3.4×10^9	5.5×10^9

Source: Battelle 1973.

IV. CONCLUDING REMARKS

The report has dealt with two broad topics: growth and siting. If there is any general conclusion arising from this study, it is the strong character of the links uniting these two topics. With some limited exceptions, as in the case of arid lands, it is difficult to tie questions of growth directly back to the environment. The transition, however, can be made by examining growth in terms of siting. In this way concentration versus dispersion really becomes an issue of air pollution and automobile use generated by lower density population distribution. The siting of highways, airports, and other indirect sources become critical determinants in the resulting development patterns.

In the case of non-degradation, the proposed EPA regulations have thus far focused on this as an expression of an industrial and energy facility siting issue. As further study and analysis are completed, other siting issues may be identified as being important factors with respect to future degradation. Growth in critical areas, on the other hand, encompasses a wide variety of siting issues resulting in decisions to initiate new construction, mining, and agriculture in areas environmentally unsuited for such activities.

There is not a set of conclusions to this report in the traditional sense. To try and fix priorities for the diverse topics covered would only serve to conceal the important regional differences in both the nature and magnitude of environmental/land use problems to be faced. Moreover, many questions have been raised in this discussion which at present have no answers. It is hoped, therefore, that rather than considering this report as the last word in environmental and land use relationships, the reader will consider it only a beginning in the formulation of a new approach available to assist EPA in fulfilling its mandate.

APPENDICES

1406

APPENDICES
CONTENTS

Page

A. List of Abbreviations 141

B. Airport Siting 142

C. Highway Siting 168

D. Residential Development 209

E. Agricultural Land Use and Forestry/Silviculture 235

F. Energy Facilities

  1. Fuel Minerals Land Use 277

  2. Electricity Generation and Transmission Facilities Siting 306

  3. Petroleum Refinery Siting 327

  4. Tank Farm Petroleum - Storage Vessel Siting 351

G. Bibliography 363

Appendix A
LIST OF ABBREVIATIONS

AAQ	Ambient air quality.
AQCR	Air Quality Control Region.
CEQ	Council on Environmental Quality.
DOI	U. S. Department of Interior.
DOT	U. S. Department of Transportation.
EDA	The Economic Development Administration of the U. S. Department of Commerce.
EIS	Environmental Impact Statement.
EPA	U. S. Environmental Protection Agency.
FAA	Federal Aviation Administration.
FHWA	Federal Highways Administration.
HC	Hydrocarbon.
HUD	U. S. Department of Housing and Urban Development.
LUPA	National Land Use Policy and Planning Act.
MW	Megawatts.
NEC	Northeast Corridor.
NO_x	Oxides of nitrogen.
PUD	Planned Unit Development.
SMSA	Standard Metropolitan Statistical Area.
SO_2	Sulfur dioxide.
TSP	Total suspended particulates.

Appendix B
AIRPORT SITING

I. NEED 1980-1990

A. Projected growth in passengers and freight to be carried

1. Passenger-miles are projected to double by 1980 and almost triple by 1990; the number of take-offs and landings, however, is projected to increase at a faster rate than the number of passengers enplaned indicating that the use of larger planes with greater carrying capacity will not have as much impact as the rapid increase in the use of small private planes (FAA projects a 63% growth in enplaned passengers over the next 5 years versus a 73% increase in aircraft operations.).

2. Ton miles of air freight are projected to increase almost four-fold by 1980 but will still only represent about 1/2 of 1% of all domestic intercity freight movements.

Exhibit B-I
Historical and Projected Growth In
Passenger-Miles (Billions)

	1965	1970	1980	1990
Domestic	57.9	110.2	258.5	523.2
International	12.6	25.4	79.8	180.4

Exhibit B-II
Historical and Projected Growth In
Air Freight (Millions of Ton Miles)

	1965	1970	1980	1990
Domestic	2,011.1	3,858.2	13,989.2	33,266.6

Source: U.S. Department of Transportation, 1973 Transportation Needs Report.

B. Planned allocation of FAA Airport Development and Airport Planning Funds (ADAP)

1. FAA has established a priority system for allocating ADAP funding based on criteria of type of airport, location with respect to market served, and deficiency category to be addressed. Highest priorities are assigned to expanding and/or removing operational restrictions on hub or reliever airports serving major metropolitan areas.

2. ADAP proposed allocations 1972-81 for airport expansion and new construction are shown in Exhibit B-III.

Exhibit B-III
Summary of Costs for Airport Development Program, 1972-81

Purpose[1]	5-Year Period 1972-76	5-Year Period 1977-81
A. Development of existing airports in--		
Primary system	21.8%	2.7%
Secondary system	26.2%	11.7%
Feeder system	22.8%	7.0%
Subtotal	70.8%	21.4%
B. Establishment of new airports in--		
Primary system	17.6%	62.8%
Secondary system	7.4%	11.3%
Feeder system	4.2%	4.5%
Subtotal	29.2%	78.6%
Total	100.0%	100.0%
C. Estimated Level of Assistance (50-50 matching grant) In Billions	$1.3	$1.0

[1] Primary System=Hub Airport
Secondary System=Reliever Airport
Feeder General Aviation Airport

Source: Airport World. December 1971. p. 16.

C. The projected number of new airports by type and acreage needed to meet 1980 estimated demand are shown in Exhibit B-IV.

1. Exhibit B-IV
New Facilities Needed by 1980

Type of Airport	Number	Average Range of Acreage Requirements*	
Primary (Major Hub)	12	60,000	240,000
Secondary (Reliever)	225	225,000	1,125,000
General Aviation	645	12,900	32,250
Total	882	297,900-1,397,250	

*Includes facility and incorporated buffer zone

Sources: New York Times, April 28, 1973, p. 58. Journal of Commerce, January 5, 1973, p. 3. Business Week, 1971 Annual of Major Issues.

2. The total maximum acreage requirement is approximately equal to the area of the State of Delaware (1,316,480 acres) with each hub jetport of 18,000 acres or more being equal or greater than the island of Manhattan (18,000 acres).

D. The need for new airports to relieve certain corridors that are at or near critical capacity is primarily centered in the Northeast Corridor (Boston-Washington, D.C.) and Chicago's five corridors.

- Congestion in these corridors can be measured in terms of passenger delay time (an average of 6.6-30 minutes per passenger depending on airport and year) or cost to carriers due to delay (an estimated $158 million from 1968 to 1969 in Northeast Corridor).

E. It is generally conceded by FAA and the Airport Operators Council International that the number of new airports estimated to meet 1980 needs will not be constructed on time, if at all.

1. FAA's short-term concern is to fill existing options for major airports close to population centers (e.g. Chicago and Atlanta). Proposals for "super-regional" interchange airports (e.g. serving the Midwest) are not considered serious options for at least 25 years.[1]

2. Only two major hub airports are now being built, in Kansas City and in Dallas-Fort Worth, both of which were started before the passage of the Airport and Airways Development and Revenue Act of 1970. The 1970 Act confines airport development projects to those that "shall provide for the protection and enhancement of the national resources and the quality of the environment of the nation." As a result of environmental and political pressures, the executive director of the New Orleans Aviation Board and past president of the Airport Operators Council International announced in September 1972, "so far as I know, there are no new airports where construction is even imminent."

3. It is estimated that to comply with the law, it will take 20 months to complete a study, 2 to 5 years to get approval, and 10 to 20 years to build an airport.

---

[1] U.S. Congress. Hearings FY -72, op. cit., p. 884.

4. Because of the problems of finding environmentally suitable sites near urban areas, the Presidential Aviation Advisory Committee has recently recommended that the number of major new primary airports proposed by FAA be reduced from 12 to 3 by 1985 and that a much greater emphasis be placed on upgrading general aviation airports to handle short-haul air passenger service.[1]

F. Airport Expansion

1. While new construction will remain limited in the near future, there will be a very strong emphasis on expanding or improving existing facilities.

2. There are 3 principal variations to the expansion process.

   a. Enlarging hub airport capacity to handle more scheduled commercial flights either through the construction of parallel runways (to handle more planes) or extension and strengthening of runways (to handle larger planes).

   b. Development of separate general aviation runways at hub airports to handle taxi and feeder service (increases the capacity of existing commercial runways and generally requires less land consumption than parallel runways).[2]

   c. Convert general aviation airports to reliever airports principally through better instrumentation and/or runway extension (permits the diversion of short haul traffic away from hub airports).[2]

G. Regional Distribution

1. The regional distribution of hub airports is shown in Exhibit B-V.

2. The distribution of aircraft ownership is shown in Exhibits B-VI and B-VIII.

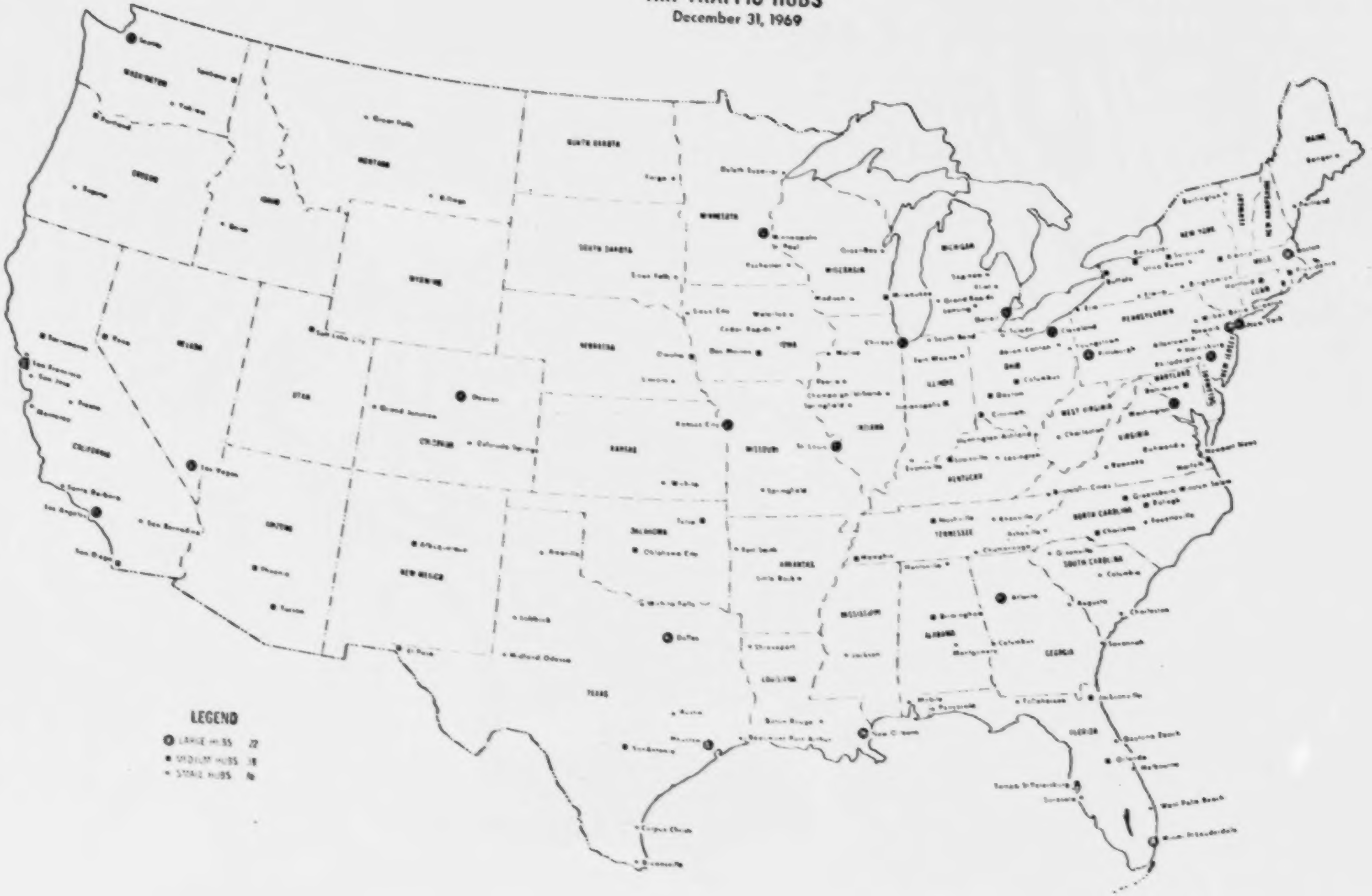
   Note: In these exhibits the term "eligible aircraft" refers to an aircraft with a current air-worthiness certificate which through a periodic or progressive inspection has been renewed within the past 12 months.

---

[1] Journal of Commerce, January 5, 1973, p. 3.

[2] General aviation accounts for 98% of all civilian aircraft in the nation (103,600 general aviation airplanes versus 3,000 airliners); 79% of the airplane hours flown; 71% of the airmiles flown and carries one-half of the people who fly intercity in the U.S. (Source: Nation's Cities, April 1972, p. 36.)

Exhibit B-V

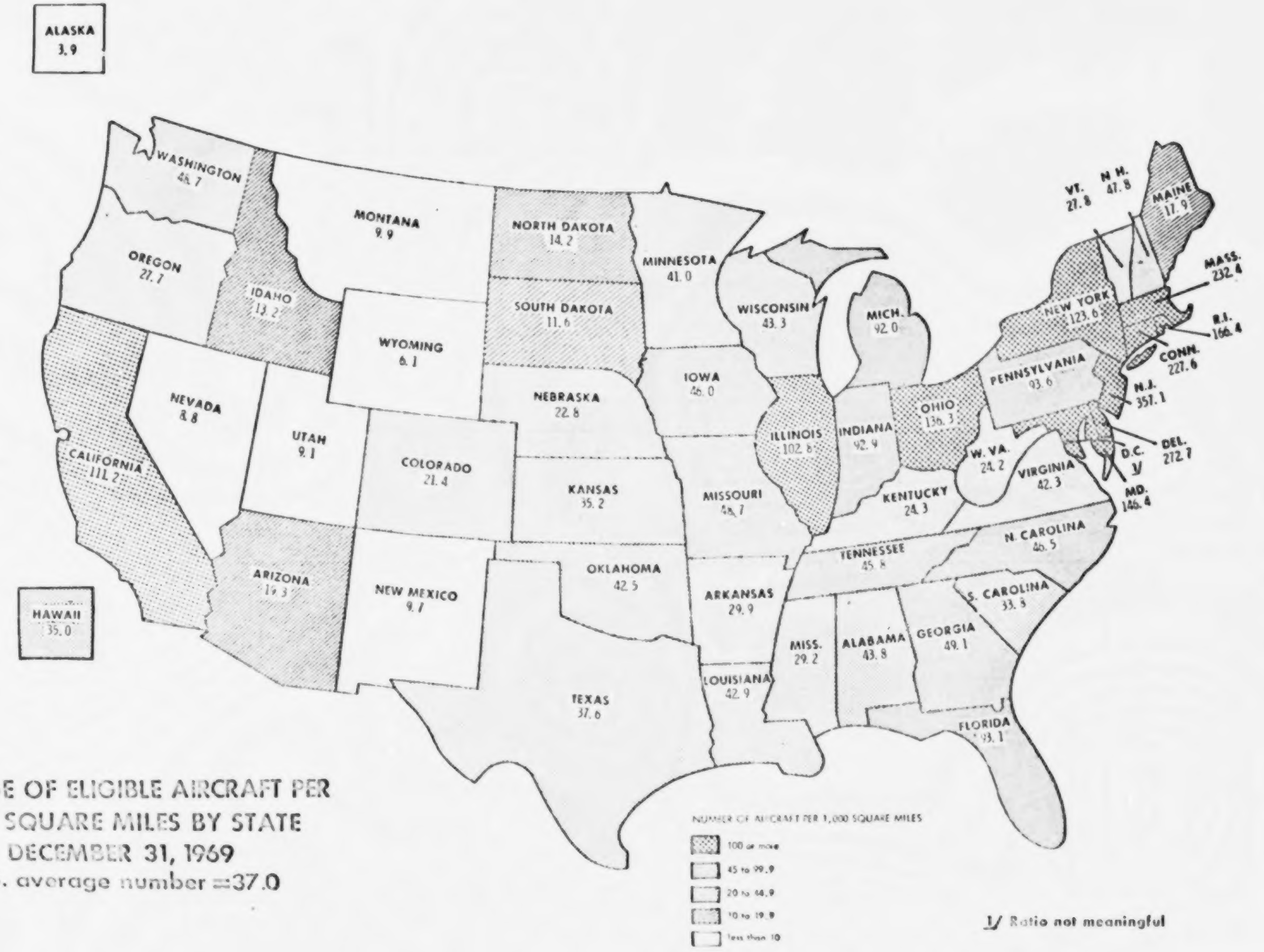


AIR TRAFFIC HUBS
December 31, 1969

LEGEND
LARGE HUBS
MEDIUM HUBS
SMALL HUBS

Source: U.S. Department of Transportation, FAA Statistical Handbook of Aviation, 1970 Edition.

Exhibit B-VI

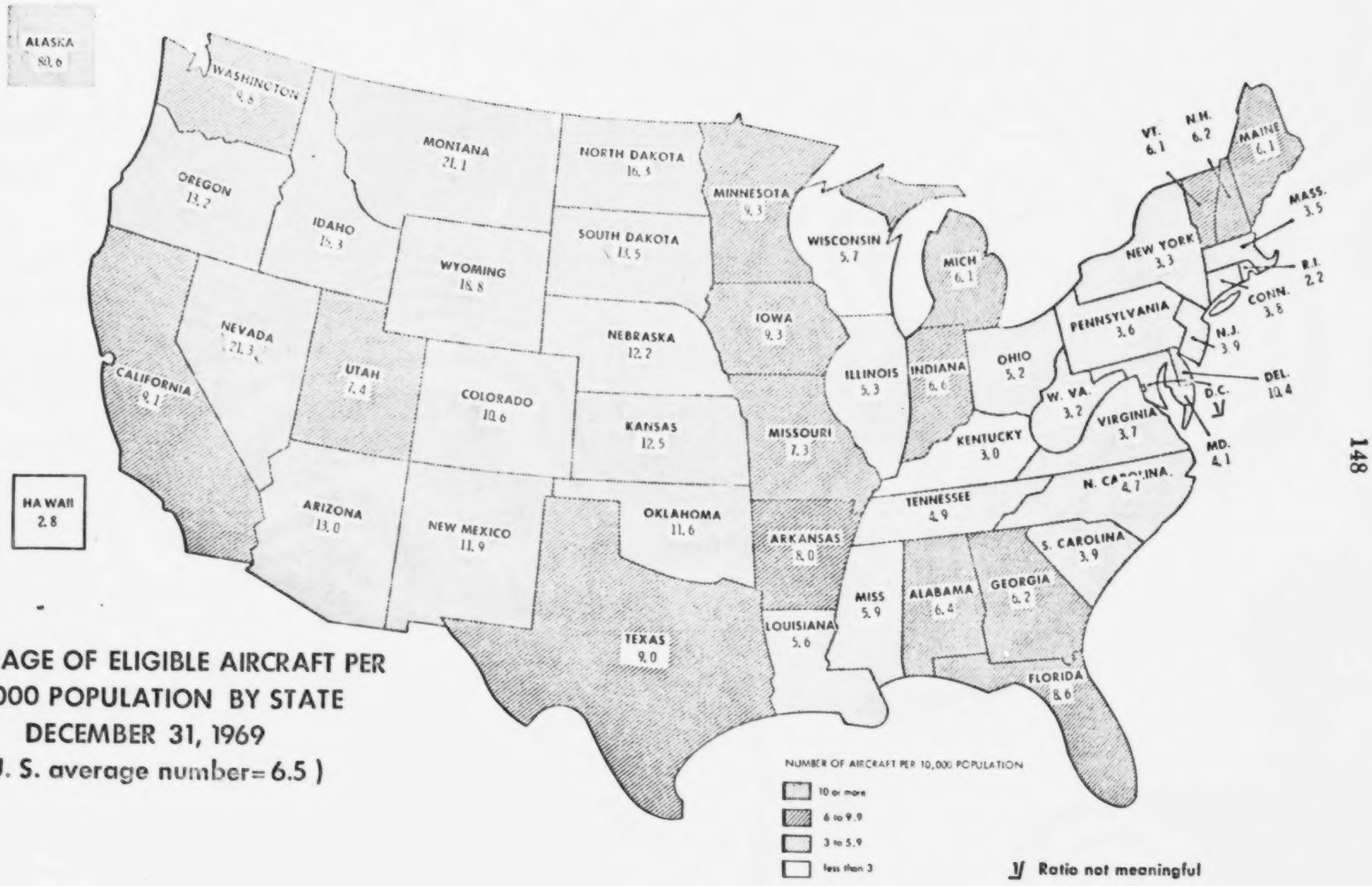

ALASKA
3.9
WASHINGTON
46.7
OREGON
27.7
CALIFORNIA
111.2
NEVADA
8.8
IDAHO
13.2
MONTANA
9.9
WYOMING
6.1
UTAH
9.1
ARIZONA
19.3
COLORADO
21.4
NEW MEXICO
9.7
NORTH DAKOTA
14.2
SOUTH DAKOTA
11.6
NEBRASKA
22.8
KANSAS
35.2
OKLAHOMA
42.5
TEXAS
37.6
MINNESOTA
41.0
IOWA
46.0
MISSOURI
46.7
ARKANSAS
29.9
LOUISIANA
42.9
WISCONSIN
43.3
ILLINOIS
102.6
MICH.
92.0
INDIANA
92.9
OHIO
136.3
KENTUCKY
24.3
TENNESSEE
45.8
MISS.
29.2
ALABAMA
43.8
GEORGIA
49.1
FLORIDA
93.1
S. CAROLINA
33.3
N. CAROLINA
46.5
VIRGINIA
42.3
W. VA.
24.2
PENNSYLVANIA
93.6
NEW YORK
123.6
VT.
27.8
N.H.
47.8
MAINE
17.9
MASS.
232.4
R.I.
166.4
CONN.
227.6
N.J.
357.1
DEL.
272.7
D.C.
1/
MD.
146.4
HAWAII
35.0
NUMBER OF AIRCRAFT PER 1,000 SQUARE MILES
100 or more
45 to 99.9
20 to 44.9
10 to 19.9
less than 10

AVERAGE OF ELIGIBLE AIRCRAFT PER
1,000 SQUARE MILES BY STATE
DECEMBER 31, 1969
(U. S. average number =37.0

1/ Ratio not meaningful

Source: U.S. Department of Transportation, FAA Statistical Handbook of Aviation, 1970 Edition.

Exhibit B-VII


ALASKA 80.6
HAWAII 2.8
WASHINGTON 9.8
OREGON 13.2
CALIFORNIA 9.1
NEVADA 21.3
IDAHO 15.3
MONTANA 21.1
WYOMING 18.8
UTAH 7.4
ARIZONA 13.0
COLORADO 10.6
NEW MEXICO 11.9
NORTH DAKOTA 16.3
SOUTH DAKOTA 13.5
NEBRASKA 12.2
KANSAS 12.5
OKLAHOMA 11.6
TEXAS 9.0
MINNESOTA 9.3
IOWA 9.3
MISSOURI 7.3
ARKANSAS 8.0
LOUISIANA 5.6
WISCONSIN 5.7
ILLINOIS 5.3
MICH 6.1
INDIANA 6.6
OHIO 5.2
KENTUCKY 3.0
TENNESSEE 4.9
MISS 5.9
ALABAMA 6.4
GEORGIA 6.2
FLORIDA 8.6
S. CAROLINA 3.9
N. CAROLINA 4.7
VIRGINIA 3.7
W. VA. 3.2
PENNSYLVANIA 3.6
NEW YORK 3.3
VT. 6.1
N.H. 6.2
MAINE 6.1
MASS. 3.5
R.I. 2.2
CONN. 3.8
N.J. 3.9
DEL. 10.4
D.C. 1/
MD. 4.1
NUMBER OF AIRCRAFT PER 10,000 POPULATION
10 or more
6 to 9.9
3 to 5.9
less than 3
1/ Ratio not meaningful

AVERAGE OF ELIGIBLE AIRCRAFT PER 10,000 POPULATION BY STATE
DECEMBER 31, 1969
(U. S. average number= 6.5)

Source: U.S. Department of Transportation, FAA Statistical Handbook of Aviation, 1970 Edition.

3. For the planning period extending through 1984, FAA will be concentrating its airport investments in the South, the West, and the Northeast.

4. In the near future, areas receiving special attention include: Aspen, Colorado; Norfolk, Virginia; Elko, Nevada; Fargo and Minot, North Dakota; and Charlottesville, Virginia; additional funds are being allocated for the completion of the Atlanta and Dallas/Fort Worth airports.

II. ENVIRONMENTAL IMPACT

A. Primary Impact

1. Noise Pollution[1]

a. The area of land encompassed by the 110 PNdB takeoff contour of a long-haul four engine civil jet is approximately 600 acres; the additional area of land encompassed by the 100 PNdB contour is approximately 7,000 acres.

b. In 1971 DOT and NASA estimated that 1,300 square miles of land in the U.S. containing 15 million individuals were affected by noise exposure corresponding to 30 NEF or greater due to aircraft operations (30 NEF = unacceptable noise level).

c. For 1978 it was projected that the land areas affected would rise to 1,800 square miles encompassing 24 million individuals.

d. The amount of noise pollution from a new airport facility will vary depending on the following characteristics:

(1) Number and type of planes to use the facility

(a) Jetliners developed within the last 5 years--notably the Boeing 747, Lockheed L-1011 and McDonnell-Douglas DC-10--use engines that are inherently quieter than the power plants of older aircraft like the 707 and DC-8.

(b) Newer aircraft have superior performance in terms of less time--and therefore less noise impact--over a community (reach a higher altitude earlier).

(c) Older planes, however, comprise more than 80% of the nation's existing jet fleet.[2]

(2) Scheduling of the frequency of takeoffs and landings (e.g. noise from night-time flights are generally considered more disruptive and irritating to humans.)

---

[1] Magnitude of impact information is largely drawn from: National Bureau of Standards/ EPA, The Economics of Noise Pollution, Dec. 1971, p. 27.

[2] New York Times, April 29, 1973, p. 58.

(3) Topography and adjacent water bodies (Natural barriers to noise and flights over water can help minimize some of the noise impact on communities.)

(4) Adjacent land use (Existing and projected land use adjacent to a new airport site can significantly affect the magnitude of the noise problem. FAA has developed a series of noise sensitivity codes and recommendations to determine land use compatibility for aircraft noise.)

e. When the above four factors are taken into account, the land use requirements for new airport sites and their surrounding buffer zones increase substantially. For example, a simulation model developed for the Dallas/Fort Worth jetport found that acceptable noise levels could only be met by setting the airport boundaries surrounding an area of 18,000 acres. This compares to an area of 2,600 acres for San Francisco International and 4,930 for Kennedy.

f. Types of noise impact:

- Tension, irritation, disruption of speech (especially to occupants or users of residential, hospital, and playground facilities).
- Damage to historical monuments in national parks.
- Ecological impact is largely unknown (e.g., life cycles of plants and animals).

2. Air Pollution

a. On a nationwide basis the contribution of aircraft in terms of total emissions seems relatively insignificant; for 1969 it has been estimated that aircraft accounted for 1.9% of the CO emissions, 0.3% of the particulate emissions, 0.3% of the SO_x emissions and 1.7% of the NO_x emissions.[1]

b. The nationwide percentages, however, hide the extremely important impact that aircraft operations can have at the local level; Exhibit B-VIII compares emission densities for four urban areas and their airports for 1970, 1975, and 1980.

---

[1] U.S. Department of Transportation, A Statement on National Transporation Policy, 1971, Figure 7.

Note: The category "Airport - All emission sources" shown in Exhibit B-VIII pertains to emissions from non-aircraft sources on and around the airport and includes airport heating plants, fuel storage losses, automobiles, service vehicles, and areas neighboring the airport.

c. On the basis of concentration of passenger activity, proximity of the airport to built-up areas, and meteorological pollution potential (a function of atmospheric mixing height and wind speed), a 1972 study found that seven of the 20 largest U.S. air carrier airports could be expected to be particularly important contributors to localized air pollutant concentrations up through 1980; these airports include O'Hare, Los Angeles, Atlanta, J.F. Kennedy, La Guardia, Dallas (Love), Washington (National).

3. Water Pollution

a. Generally restricted to petroleum product wastes, carried by run-off from paved surfaces.

b. Some specific siting decisions may increase the occurrence and impact from airport-related water pollution (e.g., the location of Atlanta's municipal airport straddling the headwaters of the Flint River).

c. Other airport-related water pollution problems may stem from:

- Sedimentation from erosion during construction
- Contamination of ground water from paving of aquifer recharge zones
- Sanitary loading from airport terminal facilities
- Change in drainage patterns through paving resulting in unacceptable reduction in stream flow, flooding, erosion and sediment accumulation.

---

[1] U.S. EPA, Aircraft Emissions:Impact on Air Quality and Feasibility of Control, 1972.

Exhibit B-VIII

COMPARISON OF EMISSION DENSITIES FOR AIRPORTS VERSUS URBAN AREAS FOR 1970, 19[illegible] 1980

	Area,[a] mi²	Emission densities,[b] tons/mi²-day								
		1970			1975			1980		
		Carbon monoxide	Hydro-carbons	Nitrogen oxides	Carbon monoxide	Hydro-carbons	Nitrogen oxides	Carbon monoxide	Hydro-carbons	Nitrogen oxides
Los Angeles metropolitan area	1250.0	7.2	2.0	1.0	4.8	1.1	0.9	2.8	0.9	0.8
Los Angeles Airport - all emission sources	3.9	20.6	10.3	2.0	20.2	7.4	3.5	19.1	4.0	5.6
Los Angeles Airport - aircraft alone	3.9	11.2	8.8	1.1	11.7	6.1	2.6	13.0	3.4	4.9
New York metropolitan area	320.0	14.5	3.4	3.6	11.4	2.4	3.6	5.5	1.3	3.2
Airport - all emission sources	4.5	19.6	7.7	2.1	16.2	4.9	2.7	11.2	2.4	3.0
Airport - aircraft alone	4.5	7.7	5.8	0.8	6.9	3.5	1.5	6.5	1.7	2.3
Washington D.C. metropolitan area	61.0	12.5	1.7	1.7	7.9	1.1	1.5	3.3	0.4	1.3
National Airport - all emission sources	1.0	10.2	2.4	1.7	10.1	2.3	1.8	9.5	2.1	1.9
National Airport - aircraft alone	1.0	6.6	1.7	1.0	7.4	1.9	1.2	8.3	2.0	1.4
Chicago metropolitan area	227.0	8.1	2.5	1.4	6.3	1.7	1.4	1.4	0.9	1.2
O'Hare Airport - all emission sources	6.7	14.1	5.4	1.9	12.9	3.6	2.0	9.1	2.0	2.3
O'Hare Airport - aircraft alone	6.7	6.0	3.9	0.8	5.7	2.6	1.3	5.5	1.5	1.8

[a] Airport areas represent those areas devoted to the operation of the airport, but not necessarily the total area owned by the airport.

[b] Emissions used to calculate airport emission densities are based on all aircraft emissions within each airport area.

Source: U.S. EPA, Aircraft Emissions: Impact on Air Quality and Feasibility of Control, 1972, p.32.

4. Ecological Balance

   Disturbance of ecological balance through drainage of wetlands, rivers or lakes.

B. Secondary Impact

1. Pollution generated by land use attracted to areas adjacent to the airport

2. Types of activities attracted to airport sites

   a. Commercial (hotels, motels, restaurants, office complexes)

   b. Industrial (Primarily industries producing high value, relatively light weight goods and/or require fast transport to reduce inventory requirements at regional sales districts, e.g., electronics firms)

   c. Residential complexes to meet labor needs of airport-attracted industrial activities (e.g., the planned community of Reston and Dulles International Airport)

3. General aviation airports are also a strong attraction to industries (e.g., glassworks, computer equipment manufactures)

   a. Although the number of industrial and commercial activities attracted by general aviation airports is substantially less than that at hub airports, their impact is substantially greater in terms of dispersion of activities.

   b. Of the 10,000 airports in the country, only 515 (relievers and hub) have scheduled airline service.

4. A somewhat different trend is the development of general aviation facilities as part of industrial parks and recreational complexes (in 1970 there were more than 300 of these).

III. KEY NON LAND-USE VARIABLES THAT CAN REDUCE THE ADVERSE ENVIRONMENTAL IMPACT OF AIRPORTS

A. Air Pollution Control

1. Aircraft smoke reduction - The aircraft industry is cutting smoke pollution from existing airplane engines. The industry entered a voluntary agreement in 1970 with the Department of Health, Education, and Welfare (HEW), which then administered the air pollution control program, and with DOT to retrofit the widely used JT8D jet engines with smoke reduction devices. Over 3,000 Boeing 727's and 737's and Douglas DC-9 aircraft engines are involved. As of March 31, 1972, 2,625 engines, or 78 percent of the total, had been retrofitted. The schedule calls for the program to be substantially completed by the end of 1972. Retrofit involves installing new combustors for more efficient burning of fuel in the engines. This in turn significantly reduces particulate matter, carbon monoxide, and hydrocarbon emissions. All JT8D engines produced since February 1970 have been equipped with smokeless combustors. The JT8D-type engine is presently used by about 80% of the nation's fleet.

   Source: CEQ, 3rd Annual Report.

2. Develop a new combustor for the JT3D-type engine (a turbojet which lifts the 707, DC-6 and others) - at present the "engine seems intractable."

   Source: Technology Review, May, 1973, p.45.

3. Develop technology suitable for air pollution control of STOL, VTOL, and the SST.

4. Restrictions on Taxiing

   During its visit at an airport, an aircraft emits most of its pollutants while taxiing. One method of controlling air pollution during ground operations is to require an aircraft to taxi on only one or two engines, depending on type, and also by permitting start-up of these engines only after clearance signal from control tower to prepare for take-off. The problem with this method of control is the possible safety trade-off, i.e., detection of mechanical problems with an engine is possible only after it has fully warmed up.

5. Exhibit B-IX summarizes the potential benefit factor[1] or relative effectiveness of various methods of controlling airport-related emissions.

6. On July 6, 1973, EPA set air pollution emission standard for aircraft; the regulations provide for the following:

    a. The 1979 standards for all turboprop engines and turbofan or turbojet engines with less than 8,000 pounds thrust represent reductions of 80% for hydrocarbons, 60% for carbon monoxide and 20% for nitrogen oxides. Aircraft using these engines include such plants as the Lear Jet, Gruman Gulfstream, Lockeed Electra.

    b. The 1979 standards for jet engines with over 8,000 pounds thrust represent reductions of 60% for carbon monoxide, 70% for hydrocarbons and 50% for nitrogen oxides. This group covers most large commercial jets including the Boeing 707, 727, 737 and 747 and the DC-8 and 9.

    c. The December 31, 1979 standards for all piston engines represent reductions of 30% for hydrocarbons, 50% for carbon monoxide and maintenance of existing levels for nitrogen oxides. This group includes most general aviation planes.

    d. EPA also has proposed requiring a retrofit on all pre-1979 large gas turbine engines. All of the emission retrofits would have to be completed by January 1, 1983.[2]

7. Although the standards are concerned specifically with control through engine modification, special trial programs on aircraft ground operations controls are underway at Los Angeles International Airport and Washington National Airport.

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[1] The potential benefit factor (PBF) is the net emission reduction resulting from a particular control strategy, averaged over the next 20 years, divided by the cost.

$$PBF = \frac{FYE \times CE \times ECF}{CP}$$

where FYE is the fraction of the next 20 years that the control method is effective; CE is the control method effectiveness (the percentage reduction of a particulate pollutant); ECF is the emission contribution fraction (percentage of total aircraft emissions at relevant airports contributed by engines affected by this control strategy); and CP is the cost of the control strategy for the pollutant considered. Emissions at major carrier airports were used to determine effectiveness of turbine engine control methods and those at general aviation airports to determine effectiveness of piston engine emission control methods.

[2] Source: letter from Paul G. Keough, Director, Public Affairs Division, U.S. EPA, dated August 14, 1973.

Exhibit B-IX
Comparison of Emission Control Methods

Control Method	Potential Benefit Factor		
	HC & CO	NO_x	Smoke
Turbine Engines			
A. Retrofit-Engine Modifications			
1. Minor combustion chamber redesign	0.37	0.37	0.37
(APU)	(2.5)		
2. Major combustion chamber redesign	0.3	1.1	1.1
(T3 and APU)		(6.6)	
(T2 only)			(5.0)
3. Fuel drainage control	10	--	--
(T2 and T3 only)	(20)		
4. Divided fuel supply	1.5	--	--
5. Water injection	--	1.4	--
(T3 only)		(4.2)	
6. Compressor air bleed	1.3	--	--
B. New Production Engine Modification			
1. Minor combustion chamber redesign	5.0	5.0	5.0
2. Major combustion chamber redesign	4.6	4.6	4.6
3. Fuel drainage control	30	--	--
4. Divided fuel supply	5.0	--	--
5. Water injection	--	1.4	--
(T3 only)		(4.2)	
6. Compressor air bleed	4.0	--	--
C. Future Engine Emission Control			
1. Fuel drainage control	30	--	--
2. Divided fuel supply	15	--	--
3. Water injection	--	2.0	--
(T3 only)		(5.6)	
4. Compressor air bleed	15	--	--
5. Variable geometry combustion chamber	25	25	25
6. Staged injection combustor	25	25	25
D. Ground Operations Modification			
1. Increase engine idle speed	2.4	--	--
2. Increase speed, reduce number	10^5	--	--
3. Eliminate delays	10	--	--
4. Transport passengers	0.1	--	--
5. Tow aircraft	75	--	--
6. Reduce APU operation	1.0	--	--
Piston Engine			
A. Retrofit-Engine Modification			
1. Fuel-air ratio control	50	--	--
2. Air injection	5	--	--
3. Thermal reactor	2	--	--

Exhibit B-IX (Cont'd)
Comparison of Emission Control Methods

Control Method	Potential Benefit Factor		
	HC & CO	NO_x	Smoke
4. Catalytic reactor	1.5	--	--
5. Direct-flame afterburner	1	--	--
6. Water injection	2	--	--
7. Positive crankcase ventilation	3	--	--
8. Evaporative emission control	1.5	--	--
B. New Production Engine Modifications			
1. Fuel-air ratio control	500	--	--
2. Air injection	30	--	--
3. Thermal reactor	6.6	--	--
4. Catalytic reactor	5.0	--	--
5. Direct-flame afterburner	3.3	--	--
6. Water injection	15	--	--
7. Positive crankcase ventilation	50	--	--
8. Evaporative emission control	3.0	--	--
C. Future Engines			
1. Fuel-air ratio control	500	--	--
2. Air injection	30	--	--
3. Thermal reactor	6.6	--	--
4. Catalytic reactor	5.0	--	--
5. Direct-flame afterburner	3.3	--	--
6. Water injection	15	--	--
7. Positive crankcase ventilation	50	--	--
8. Evaporative emission control	6.0	--	--
9. Engine redesign	25	--	--
D. Ground Operations Modifications			
1. Eliminate delays	10	--	--

Source: U.S. EPA, Aircraft Emissions Impact on Air Quality and Feasibility of Control, 1972, pp. 71-78.

B. Noise Pollution

1. Controlling noise during approach phase (compressor technology is available, but very costly. It's estimated that the domestic fleet of conventional aircraft could be retrofitted for from 3/10's of a billion dollars to $1.5 billion.[1]
   Also reduce flap settings.)

2. Controlling noise during take-off. Technology has not yet solved this problem. (NASA is looking at acoustical treatment in the hot portions of the exhaust.)

3. Imposing curfews between midnight and 6 A.M. - reduces noise interference with sleeping, but also creates scheduling problems for long-haul flights and limits airport capacity.

4. Current FAA rules lay down noise criteria that are met by only 10% of the 2,000 large civil transport planes.

   a. BACT makes it possible to overhaul the other aircraft, but the airlines have been resisting this because of the high cost involved.

   b. EPA noise regulations for aircraft are due sometime in the winter of 1973.

C. Other Non Land-Use Techniques for Controlling Primary Impact

1. Larger planes

   - more economical, lower set/mile operating costs
   - alleviation of some saturation at least on runways, taxiways, and apron
   - less pollution, but . . .

   may require complete rebuilding of today's airports because of the need for wider, thicker and longer runways and taxiways, as well as greater turning areas and double-deck terminals

2. Assigning each airline an average permissible decibel level -- represents one proposed plan for Federal action; for a major curling with a wide assortment of planes - including the really noisy ones (early 707's and DC-8's). The only way to operate would be to add enough newer, quieter planes to stay below the average noise level assigned to it. It would also have to fly its new planes more and its old planes less, or it might choose to re-equip its old planes with quieter engines. The problem with this proposal is that airlines may concentrate new planes in airports with frequent take-offs and landings and use older planes in more environmentally clean areas.

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[1] U.S. Congress, Hearing F.Y. 1972, op. cit., p. 597.

3. A breakthrough in V/STOL and/or high speed rail technology (especially for short haul trips of approximately 600 miles or less)

4. Acoustical insulation of surrounding residential structures

   The National Bureau of Standards estimates that the cost of insulating houses is on the same order of magnitude as that of land acquisition near airports. The indirect economic consequences of insulation are not as severe as those caused by the relocation of nearly 4,000,000 families. It would seem, however, that neither alternative for reducing the impact of aircraft noise by insulating the receiver is economically viable. Land acquisition and the resulting dislocation of families could have serious consequences on the general economy, but insulation of homes is merely a method of treating the symptom rather than the disease. To escape the annoyance of aircraft, people would have to remain in houses sealed against sound. The outdoors would still be subject to aircraft noise.[1]

5. Flight - space restrictions

   In order to reduce the impact of noise, flight-space restrictions are frequently imposed and certain segments of the airways are not available to the jet fleet. This further reduces the capacity of both airports and aircraft and also contributes to operating delays, which are costly to both travelers and the airlines. DOT-NASA have estimated that noise restrictions alone could reduce the capacity of an airport by 20 percent. The annual aircraft-delay cost for an airport with 450,000 operations annually has been estimated at $11 million. This is exclusive of the time lost by passengers, the inconvenience of missed connections due to delays, and so forth.[2]

6. Increase capacity of existing facilities without expanding land area occupied

   a. It is estimated that airport capacity could be almost doubled,in several cases, through the use of closely spaced parallel runways (2,500 ft). But to do this requires technological advances in instrumentation systems, such as the development of the Microwave Instrumentation Landing System.

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[1] National Bureau of Standards/EPA, The Economic Impact of Noise, December 31, 1971.

[2] Idem.

   b. Another alternative is to increase the number of instances of joint use of military airfields for civilian operations.

D. Control of secondary impact - industry control, auto pollution control

--Industrial and auto pollution control devices

IV. EFFECT OF LAND USE/LOCATIONAL DECISIONS IN REDUCING THE ADVERSE ENVIRONMENTAL IMPACT OF AIRPORT SITING

A. Hub versus General Aviation Airports

1. Concept involves having perhaps 30 to 50 well-distributed, small, "basic utility" type airports instead of 1 to 3 major jetports.

2. Advantages of the concept include small acreage requirements, less noise, convenience to surrounding communities (one within approximately 30 minutes access time of the majority of U.S. citizens, and increased ability to service mail, taxi, personal and business uses).

B. Concentration versus Dispersion

1. Airports have a very strong impact in terms of concentrating traffic and commercial (motels, restaurants, office complexes) and industrial activity (e.g., satellite industries attracted to San Francisco International account for 90,000 jobs).

2. Concentration of activities around airport sites tends to raise land values and limit expansion potential (e.g., at O'Hare in Chicago the original cost of land was $700/acre; land around the airport now goes for $125,000 to $500,000/acre).

C. Land Banking

1. This concept focuses on reserving land now for future use as airport site.

2. Advantages of land banking

   a. Less cost (in Miami it has been estimated that land for a new airport site will cost $100 million to acquire now versus $250 million in 10 years when it will be needed).

   b. Permits better planning (in terms of site specific planning) for environmental impact.

c. Permits more efficient planning for urban growth (e.g., private enterprise can plan growth to correspond to the development of the new airport site; public institutions and schools can be located away from areas of noise impact; rights-of-way can be set aside for ground transportation).

3. Problems with land banking

a. Money (airport operating entities are financed by airline rentals and landing fees, plus a percent of the gross done by concessions; just about all airport users and certainly the airlines have more immediate demands on their cash than paying higher rentals toward a proposed new airport.)

b. Political and economic (e.g., problems of loss of land to tax base)

4. On January 4, 1973, the Presidential Aviation Advisory Committee recommended that a federal national land bank program be set up.

D. Establishment of Buffer Zones

1. Buffer zones are designed to minimize the noise impact of airports on the surrounding community.

2. Buffer zones consume large quantities of land (e.g., the proposed 4th New York jetport plans call for a buffer zone of 10,000 acres, while at Dallas/Fort Worth the property line has been placed approximately 3.5 miles from the end of each runway to provide an adequate buffer zone).

3. Some options, however, for the use of buffer zones have been suggested (e.g., cemeteries and golf courses).

E. Site Layout and Design

1. Planning for placement of runways, turnoffs and taxiways to minimize idling time on the ground and to reduce saturation of airspace.

2. Setting up screens either natural or man made.

F. The use of zoning to control secondary growth and its related environmental impact on areas adjacent to airports.

G. Provision of mass transit or people-mover systems for airport access.

SUMMARY: AIRPORT SITING

1. Timing

   a. Over the next 10-12 years, construction of new major hub or regional airports will be largely insignificant; some planning efforts, however, may be of interest to EPA with regard to airport siting over the longer term (20 years).

   b. Over the next 10-12 years, much more significant efforts will be devoted to enlarging the capacity of existing airport facilities, including the conversion of a number of general aviation airports to reliever airports.

2. Magnitude (i.e., degree to which the adverse environmental impacts associated with airport siting can be controlled by non-land use vs. land use variables)

   a. Air Pollution

      (1) Pollution control devices and changes in operational procedures can largely eliminate the problems of air pollution from aircraft.

      (2) Air pollution from stationary and mobile sources, attracted by airport siting, represent a much more difficult control problem.

   b. Noise Pollution

      (1) Noise from landings can be substantially reduced through BACT, although the economic cost is still high.

      (2) Noise from takeoffs cannot be controlled using BACT, but can be alleviated in part through land use control.

   c. Water Pollution

      (1) Can be controlled at site with proper planning and engineering.

      (2) Control of secondary facilities may be more critical.

   d. Land Consumption

      (1) If all of FAA's proposed new developments were to be carried out and on time, the consumption of land would about equal the area of Delaware.

(2) The use of buffer zones to control adverse environmental impact can substantially increase the amount of land taken for a new airport (e.g., the Stewart AFB site for the proposed 4th New York airport is slightly over 1,570 acres in size; the land acquired to serve as a buffer zone covers 10,000 acres).

(3) Land consumed for secondary activities can far outweigh the amount used for the airport itself (e.g., 130 zoned industrial district/parks have located within 30 miles of the new Dallas-Fort Worth airport).

3. Irreversibility

a. Environmental Impact

--Most critical, due to impact of paving over large areas, on drainage patterns, aquifer recharge, and on ecological balance.

b. Land Use Impact

--In the case of medium-to-large-size military and civilian airports, the large capital investment requirements and the amount of land covered by paving material limits the possibility of re-use other than for airport operation.

--Secondary impact in terms of induced growth around airports can reach major proportions in certain areas.

4. Possible Conflicts

a. Restriction or slowing of the new airport development process conflicts with the federal goal of providing a balanced transportation system.

b. Air vs. Noise Pollution

(1) Restricting the number of night flights will reduce the noise disruption factor but may also cause air emissions to be concentrated at times of day when maximum pollutants from industry and highway traffic are also being emitted.

(2) Greater use of secondary airports may reduce direct effects of air pollution through dispersion but may increase indirect sources of air pollution and both direct and indirect sources of noise.

c. Safety vs. Environment

(1) Requiring a steeper rate of climb for takeoffs may lessen noise pollution but may also increase the safety hazard.

(2) Imposing quota systems at high density airports may be a good safety measure (better traffic control possible) but may increase need (or demand) for new airports.

5. Chain Effect

- Airports attract commercial and industrial activities which in turn attract housing, all of which generate large demands for highway facilities and expansion of the highway network.

6. Rural vs. Urban

a. The substantial land requirements of new hub airports are forcing planners to look more and more at rural sites.

b. General aviation airports are being shifted to rural areas too since they often fall in the path of urban-suburban spread and since they can more easily be converted into new uses (e.g., shopping centers and apartment complexes).

7. Concentration vs. Dispersion

a. Airports of all types tend to act as a concentrating force with respect to certain commercial and industrial activities.

b. In the past these secondary activities have tended to locate near major metropolitan airports; a more recent trend is for these activities to disperse, either by locating near one of the more than 10,000 general aviation airports located throughout the country or one of the rural hub airports (where congestion is less and expansion possibilities are greater).

8. Non-degradation

a. As non-transportation activities follow airports into more remote areas, the possibility of creating new indirect sources in clear air areas is increased.

b. The air pollution problems associated with airports are not just from the aircraft and adjacent industry (which tends to be "light" industry) but from the automobiles, trucks, and buses used to bring in airport, industrial, and commercial employees, air freight and industry freight, and airport travelers and visitors.

c. Since a large number of light industries tend to aggregate near airports, it may limit the options for economic development in clean air areas that are seeking light industry as a means of permitting development while minimizing degradation.

Appendix C
Part 1: HIGHWAY SITING

I. NEEDS

A. Highway systems are divided by the Federal Highway Administration (FHWA) into a hierarchy based on mobility and access functions.

1. Definitions

a. Arterials: designed to accommodate high volumes of through traffic with access severely limited in the case of freeways.

b. Collectors: provide the necessary transition from local roads and streets to arterials.

c. Local System: penetrates neighborhoods; designed for low speeds and unlimited access.

2. The Hierarchy of Functional Systems

a. Rural areas

--Principal arterial system: interstate; other principal arterials

--Minor arterial system

--Collector system: major collectors; minor collectors

--Local system

b. Small urban and urbanized areas

--Principal arterial system: interstate; other freeways and expressways; other principal arterials

--Minor arterial system

--Collector system

--Local system

B. Nationwide Needs

1. Historic Growth

a. Travel in the U.S. has doubled about every 16 years.

b. In terms of vehicle-miles of travel, the average annual growth rate over the past two decades has been 4.6%.

c. In 1970 almost three-fourths of all auto trips were under 10 miles and about 50% were under 5 miles.

d. The principal trip purpose in 1970 was travel to and from work (accounting for over 32% of the trips and more than 34% of all vehicle-miles traveled).

2. Projected Growth

a. FHWA estimates that over the next 20 years (1970-1990) travel will continue to grow at an average annual rate of 4.2% (this represents almost a two-thirds increase in annual vehicle-miles traveled between 1970 and 1990).

b. Based on the growth projection FHWA estimates that over 60.2% of all vehicle-miles of travel will be within urban areas by 1990 (versus 52% in 1968).

c. To meet the needs forecast, FHWA has calculated that the optimal national economical investment in new roadways should be increased by 52% over the 1970 investment level and further:

--that the largest increase, 63%, should be in small urban areas

--rural areas should have the smallest increase or 36%

C. Land Consumption

1. In 1968 the road and street networks in the U.S. totaled 3.6 million miles (equivalent to 1 mile of road for every square mile of land area).

2. By 1990 it is projected by FHWA that 20.8% of street and highway miles will be in urban areas versus 13.7% in 1968. Part of the increase is due to urban sprawl extending the urbanized land area from 1.3% to 2.5% of the total.

3. Exhibit C-I shows that in 1968 19.2% of all urban roadway miles were part of the arterial system and 9.2% of all rural roadway miles.

4. In terms of linear miles the local system predominates (68.4% in rural areas and 72.3% in urban areas).

Exhibit C-I

Comparison of 1968 miles of highways and daily vehicle-miles of travel on functional systems with the estimates for 1990

Area and functional systems	Miles of highways							Daily vehicle-miles of travel (thousands)						
	1968			1990			Percent change 1968-1990	1968			1990			Percent change 1968-1990
	Number	Percent of- Area miles	Percent of- Total miles	Number	Percent of- Area miles	Percent of- Total miles		Number	Percent of- Area travel	Percent of- Total travel	Number	Percent of- Area travel	Percent of- Total travel	
Rural														
Principal arterial systems:														
Interstate	22,359	0.7	0.6	31,552	1.0	0.8	41	182,057	13.7	6.5	516,106	25.4	10.1	184
Other	90,559	3.0	2.6	82,855	2.7	2.1	-9	361,681	25.7	12.1	479,576	23.6	9.4	[illegible]
Total	112,918	3.7	3.2	114,407	3.7	2.9	1	523,738	39.4	18.8	995,682	49.0	19.5	
Minor arterial system	169,061	5.5	4.7	177,803	5.7	4.5	5	298,032	22.5	10.7	436,121	21.4	8.6	46
Total arterial systems	281,979	9.2	7.9	292,210	9.4	7.4	6	821,770	61.9	29.5	1,431,803	70.4	28.1	76
Collector systems:														
Major	265,321	8.6	7.5	276,571	8.9	7.1	4	199,009	15.0	7.1	280,134	13.8	5.5	41
Minor	425,500	13.8	11.9	433,180	13.9	11.0	2	118,872	8.9	4.3	139,496	6.9	2.7	17
Total	690,821	22.4	19.4	709,751	22.8	18.1	3	317,881	23.9	11.4	419,630	20.7	8.2	32
Local system	2,106,814	68.4	59.0	2,105,228	67.8	53.7	-0.1	189,375	14.2	6.8	180,012	8.9	3.5	-5
Total all systems	3,079,614	100.0	86.3	3,107,189	100.0	79.2	0.9	1,329,026	100.0	47.7	2,031,445	100.0	39.8	53
Urban														
Small urban areas														
Principal arterial systems:														
Freeways and expressways:														
Interstate	499	0.6	1/	1,102	0.7	1/	121	5,585	2.7	0.2	23,464	7.5	0.5	320
Other	633	0.5	1/	2,034	1.2	1/	221	6,609	3.2	0.2	26,132	8.4	0.5	295
Total	1,132	0.9	1/	3,136	1.9	1/	177	12,194	5.9	0.4	49,596	15.9	1.0	307
Other principal	12,121	9.5	0.4	14,265	8.4	0.4	18	89,802	43.8	3.2	120,000	38.4	2.3	34
Total	13,253	10.4	0.4	17,401	10.3	0.4	31	101,996	49.7	3.6	169,596	54.3	3.3	66
Minor arterial system	11,708	9.2	0.3	17,444	10.3	0.5	49	38,266	18.7	1.4	63,624	20.3	1.3	66
Total arterial systems	24,961	19.6	0.7	34,845	20.6	0.9	40	140,262	68.4	5.0	233,220	74.6	4.6	66
Collector system	13,155	10.3	0.4	17,362	10.2	0.6	32	20,141	9.8	0.7	28,995	9.3	0.5	44
Local systems	89,331	70.1	2.5	117,298	69.2	3.0	31	44,829	21.8	1.6	50,214	16.1	1.0	12
Total all systems	127,447	100.0	3.6	169,505	100.0	4.3	33	205,232	100.0	7.3	312,429	100.0	6.1	52
Urbanized areas:														
Principal arterial systems:														
Freeways and expressways:														
Interstate	4,596	1.3	0.1	9,996	1.5	0.3	118	181,766	14.5	6.5	555,260	20.1	10.9	206
Other	3,437	0.9	0.1	16,380	2.5	0.6	377	116,975	9.3	4.2	620,725	22.5	12.2	431
Total	8,033	2.2	0.2	26,376	4.0	0.7	228	298,741	23.8	10.7	1,175,985	42.6	23.1	294
Other principal	26,414	7.3	0.8	37,376	5.8	0.9	42	390,284	31.2	14.0	569,622	20.6	11.1	46
Total	34,445	9.5	1.0	63,750	9.8	1.6	85	689,025	55.0	24.7	1,745,607	63.2	34.2	153
Minor arterial system	35,283	9.7	1.0	67,345	10.4	1.7	91	256,705	20.3	9.2	501,574	18.2	9.8	97
Total arterial systems	69,728	19.2	2.0	131,095	20.2	3.3	88	945,730	75.3	33.9	2,247,131	81.4	44.0	138
Collector system	30,818	8.5	0.8	57,267	8.9	1.5	86	96,965	7.7	3.5	197,958	7.2	3.9	104
Local system	261,965	72.3	7.3	458,707	70.9	11.7	75	213,020	17.0	7.6	313,761	11.4	6.2	47
Total all systems	362,511	100.0	10.1	667,069	100.0	16.5	79	1,255,715	100.0	45.0	2,758,850	100.0	54.1	120
Total rural and urban	3,569,572		100.0	3,923,763		100.0	10	2,787,973		100.0	5,102,724		100.0	83

1/ Less than 0.05 percent.

Source: 1972 Highway Needs Report, FHWA, p. III-26.

5. In terms of land consumed for rights-of-way, however, local roads consume slightly more than 3 acres/mile whereas freeways consume 24 to 36 acres/mile and approximately 80 acres per interchange.

6. Exhibit C-II shows that FHWA's projections for the time period of need for new construction projects are heavily skewed toward the near future (up to 1980).

7. Nevertheless, due to the debate over the use of part of the Highway Trust Fund for public transit resulting in Congress delaying the passage of a highway act authorizing funds for fiscal 1974 and 1975, total state highway awards so far in the first quarter of 1973 were running 34% behind the 1972 pace, a slump that is concentrated in the West and Midwest.[1]

8. The Interstate System

    a. Approximately 77% is now open to traffic.

    b. Most of the remaining uncompleted segments of the system are in urban areas and are being delayed as a result of local controversies over siting.

    c. The 1970 Federal-Aid Highway Act mandated removal of Interstate segments from the System for which a schedule for completion has not been submitted by July 1, 1973.

    d. FHWA is currently trying to extend the Interstate deadlines into the 1980's.

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[1] Engineering News Record, March 22, 1973, p. 112.

FHWA PROJECTION: Exhibit C-II
PERCENTAGE DISTRIBUTION OF RURAL AND URBAN NEEDS MILES BY TIME PERIOD OF NEED AND FUNCTIONAL SYSTEM

	1972 - 1980*	1981 - 1990
URBAN		
Interstate	58%	42%
Other Freeway-Expressway	74	26
Other Principal Arterials	84	16
Minor Arterials	82	18
Collectors	87	13
RURAL		
Interstate System	53%	47%
Other Principal Arterials	88	12
Minor Arterials	90	10
Major Collectors	93	7
Minor Collectors	93	7

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*Includes FHWA's estimates of "backlog" needs as of 1972.

D. Regional Concentration

1. The greatest concentration of needs is in the Northeast Corridor (approximately 25% of the nation's total vehicle-miles on less than 2% of the nation's land).

2. In terms of state rankings, California accounts for more than 10% of all vehicle-miles traveled; New York and Texas account for an additional 5% each.

3. Nationally, major interstate highway (urban) route controversies rage in 11 urban areas--7 of the problem areas and four-fifths of the disputed route miles are located in the Northeast Corridor.

II. ENVIRONMENTAL IMPACT

A. Direct

1. Air Pollution

a. Varies by highway segment according to number and type of vehicles, peaking of travel, congestion limiting free-flow of traffic, and the complex of meteorological and physical variables affecting turbulent diffusion.

b. Exhibit C-III gives total emissions estimates for motor vehicles.

c. In 1967 motor vehicles were responsible for causing 72% of the carbon monoxide, 49% of the hydrocarbons, a third of the nitrogen oxides, and 90% of the lead-bearing particulate matter in the nation's atmosphere.

d. Free-flowing traffic on highways is effective in reducing the amount of carbon monoxide and hydrocarbons compared to stop and go traffic on local systems (e.g., it has been estimated that traffic on central business district streets adds 42 lb. of CO/vehicle miles, while traffic on expressways contributes about a fourth that amount or 11 lb./vehicle mile.

e. NO_x emissions, in contrast, increase with speed and it is these oxides that produce Los Angeles photo-chemical smog.

f. Even under BACT "increasing" numbers of "vehicles" and the congestion they create deserves careful consideration in planning new highways.

--There is evidence that many highways create more new traffic than they divert from congested systems.

--79.6% of all households owned at least one car in 1970.

--29.3% of all households in the U.S. owned at least two automobiles in 1970, compared with 16.4% in 1960.

--The total number of motor vehicles registered is increasing by an average of 3.43 million units/year.

--Studies indicate that the number of passenger miles driven per vehicle is increasing.

Exhibit C-III
MOTOR VEHICULAR EMISSIONS: 1969 & 1980

Source Contributor	CO	Particulates	SO_x	HC	NO_x
	Emissions, 1969 (millions of tons)				
Gas Power Motor Vehicle	96.8	0.3	0.2	16.9	7.6
Diesel Motor Vehicle	1.0	0.1	0.1	0.2	1.1
	Emission Projection, 1980 (millions of tons)				
Gas Power Motor Vehicle	29.0	n.a.	n.a.	3.6	4.0
Diesel Motor Vehicle	1.0	n.a.	n.a.	0.2	1.8

2. Noise Pollution

a. Ground transportation noise varies depending on the magnitude of the noise emitted by the source, the path of transmission, the time of day, weather conditions, and the sensitivity of the receiver.

b. Bolt, Beranek & Newman has developed a methodology for estimating noise pollution for a new highway. The critical variables used are:

--Mean traffic speed

--Number of traffic signals or stop signs

--Line of sight exposure

--Percentage of trucks in the total traffic volume

--Degree of gradient

c. Studies have shown that because of their high noise levels and their frequent penetration of residential areas, trucks, buses, and motorcycles often exceed ambient sound standards.

--The number of truck, bus, and motorcycle registrations is growing at a higher rate than automobile registrations.

--Growing at almost 17% each year, the number of licensed motorcycles could double in a little over 4 years.

--At a growth rate of 4.2% per year, the number of buses and trucks could double in 17 years.

d. In 1971, Wyle Laboratories estimated that approximately 420 square miles is subject to undesirable noise levels as a result of the nation's urban freeway system.

e. Assuming the same nationwide density pattern for land adjacent to major urban freeways, there are about 5,000 people per square mile or 2.1 million within the 420 square miles impacted by noise.[1]

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[1] National Bureau of Standards, The Economic Impact of Noise (EPA, December 1971), p. 43.

3. Water Pollution

   a. Sedimentation caused by erosion of soil exposed during construction:

      --Divided highways requiring exposure of 10 to 35 acres/mile during construction produce 3,000 tons or more of sediment per mile.[1]

   b. Runoff containing salt--

      --During the winter of 1966-67, six million tons of salt were used on highways (an increase of 400 percent from 1954)

      --In Connecticut, 20 tons/mile of salt are applied to some principal highways each year

   c. Runoff containing herbicides used to control roadside vegetation

   d. Pollutants resulting from wear and tear on tires and from oils, greases and gasoline leaking from vehicles or released as a result of highway accidents; these in turn leak or dissolve other substances from the asphaltic binders used in paving materials

   e. Description of drainage patterns and ground water recharge due to paving over of large areas

4. Other Types of Impact Related to Highway Usage

   --fumes and odors
   --vibration
   --headlight glare at night

B. Indirect Impact

1. Automobile Solid Waste

   a. Each year approximately 200 million tires are discarded, representing a solid waste accumulation rate of about seven every second.

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[1] Melvin E. Scheidt, "Environmental Effects of Highways," Man's Impact on the Environment, T.R. Delwyler (ed.), McGraw Hill, 1971.

--burning tires pollute the air
--in sanitary landfills, they defy compaction and tend to gravitate to the surface

b. Approximately seven to nine million autos are discarded each year

--These are a substantial solid waste and aesthetic problem

--They also represent the tying up of substantial amounts of metallic resources, equivalent annually to about 17,724 million pounds of steel, 3,577 million pounds of cast iron, 224 million pounds of copper, 378 million pounds of zinc, and 140 million pounds of lead

c. The source of a significant percent of ocean oil pollution is from irresponsible dumping of automobile crankcase oil in sewers.

2. Impact at Interchanges

a. When completed, the Interstate Highway system alone will contain over 14,000 interchange structures

b. Gas stations tend to be strongly attracted to intersections at an average of 2.7 stations per intersection nationwide

(1) Air pollution

--When a gasoline storage tank, whether on a vehicle or at a gas station is filled, the hydrocarbon vapor displaced is vented to the atmosphere
--Nationally, such filling losses amount to a direct loss of approximately 1 to 2 percent of the total volume of gasoline sold annually or about 1 to 2 billion gallons
--Although less significant in the past, compared to the major contributions from automotive exhausts, these sources become considerably more important with the implementation of 1976 vehicle emission standards; filling losses will then be of the same order of magnitude as total vehicle emissions.[1]

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[1] U.S. Department of Commerce, Automotive Fuels and Air Pollution, (March 1971), p. 6.

(2) Water pollution

--Discarding auto crankcase oil
--Oil and gas, contained in runoff from paved surfaces

c. Other types of land use attracted to intersections

(1) A recent FHWA study of land uses at interchanges found

--in general intensive land development is occurring near the interchanges in large metropolitan areas; in small urban centers, the supply of land at interchanges tends to exceed the demand

--space needs for residential development is expected to greatly exceed that for other specific uses--industrial and commercial (shopping centers)

--while the space needed for shopping centers is by far the smallest of the three uses, the use may need careful coordination with interchange plans because of its highway traffic - generating characteristics

--restaurants, motels and churches are other activities that cluster around interchanges[1]

3. Impact Along Routeways

a. In terms of urban infiltration, a study of the southern half of the lower penninsula of Michigan found that over 92 percent of the highway mileage and a little over 82 percent of the highway frontage were found to have a depth of impact of at least one mile into the adjacent rural area[2]

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[1] U.S Department of Transportation FHWA. Economic and Social Effects of Highways, 1972, pp. 34-35.

[2] Ibid., p. 65.

b. Joint development (through excess right-of-way acquisition) and airspace usage are concepts that have been receiving much attention in recent years

(1) one of the most notable residential airspace projects is the 32-story, 960-unit, low-income complex, over the Interstate 95 approach to the George Washington Bridge in Manhattan

--noise and fumes rise from the unvented and open freeway between the buildings

--the design shortcomings have not been tested in terms of the type of financing (FHA funding and tax concessions), housing shortages, and subsidized rentals.

(2) An FHWA-sponsored study evaluated various uses of airspace above and below freeway (see Exhibit C-IV) based on a composite of criteria, including:

--tolerance of noise and fumes
--advantages of highway view
--advantage of being seen from the highway
--effect on local traffic
--reduction of barrier effect
--provision of revenue for affected governments
--profitability for the developer

Exhibit C-IV
FEASIBILITY RATINGS FOR VARIOUS USES OF AIRSPACE ABOVE AND BELOW FREEWAYS

Land use	Above the freeway			Below the viaduct freeway
	Depressed freeway	At grade freeway	Elevated freeway	
Motel or hotel	Good	Average	Average	Poor
Subsidized housing	Good	Poor	Poor	Poor
High-rise apartment	Good	Average	Average	Poor
Other residential	Poor	Poor	Poor	Poor
Office building	Good	Average	Average	Good
Parking garage	Good	Good	Average	Good
Restaurant	Average	Average	Average	Good
Individual stores	Poor	Poor	Poor	Good
Regional shopping center	Poor	Poor	Poor	Average
Bowling lanes	Average	Poor	Poor	Average
Industry	Poor	Poor	Poor	Average
Club	Average	Poor	Poor	Average
Convention hall, city hall	Good	Average	Average	Poor
Concert hall	Average	Poor	Poor	Poor
Library	Good	Average	Poor	Good
School	Average	Average	Poor	Average
Transportation terminal [1]	Good	Average	Average	Average
Park	Average	Poor	Poor	Average
Playground	Average	Poor	Poor	Good
Agriculture, heliport, hospital, monument	Poor	Poor	Poor	Poor

[1] Assumes direct access

Source: Derived from Matrix prepared by Real Estate Research Corporation, "A Study of Airspace Utillization" prepared f
California Division of Highways and U.S. Bureau of Public Roads, 1967

(3) The economic feasibility of the use of airspace depends on the cost of land adjacent to the freeway

--for example, the supporting structure for a 10-story building over a highway would cost at least $15,000 per square foot (over $600,000 per acre)

--the requirement would limit airspace development in general to the high-value areas in the center of large cities

III. NON LAND USE FACTORS IN REDUCING ADVERSE ENVIRONMENTAL IMPACT

A. Methods of Reducing the Adverse Environmental Impact of Highways Take Three Forms

1. Control over motor vehicle design.

2. Control over use of motor vehicle.

3. Controls over the design and construction of the highway.

B. Air Pollution

1. Control related to highway construction activity.

   a. Nonburning techniques for the disposal of brush and timber removed by highway projects.

   b. Dust collection systems used on hot-mix asphalt plants and other types of plants used primarily for highway construction (by the end of 1970 all but six states required dust collection systems).

2. Control of vehicle emissions.

   a. Exhibit C-V, Tables a and b, shows the types of mobile source emission controls that can be applied and their impact on reducing the level of emissions.

   b. Change to unconventional power sources.

   --hybrid power systems consisting of internal combustion engines with electric driving motors
   --gas turbine engine
   --Wankel rotating internal combustion engine

Exhibit C-V
CONTROL TECHNIQUES FOR MOBILE SOURCE EMISSIONS

Table a

Model Year		Autos and Light Duty Trucks Typical Changes or Controls Added	Emissions Per Vehicle as Percent of 1967 Vehicle Level HC	 CO	 NO_x
1967		None	100	100	100
1968-1969		Closed PCV system, carburetor changes, ignition timing changes, inlet air temperature control	53	45	111
1970		Additional carburetor changes, idle control solenoid, ignition timing changes	40	32	85
1971		Evaporative emission control, improved idle control solenoid with overheat protection (including transmission spark control), low compression ratios, additional carburetor changes	25	32	85
1972		Valve and valve seat changes for unleaded gasoline	20	28	69
1973-1974		Exhaust gas recirculation for NO_x control, speed controlled spark timing	20	28	42
1975	Alternative 1	Catalytic oxidation of HC and CO (includes long-life exhaust system), unitized ignition systems for 50,000 mile service-free performance, air injection for catalytic unit	12	16	42
1976-1977		Dual catalyst units for HC, CO, and NO_x; or tandem NO_x and CO-HC catalytic units; modified manifold reactors to reduce catalyst load	3	3	6
1975	Alternative 2	Extremely lean fuel mixtures (unitized electronic ignition with electronic control of spark timing), electromechanical fuel injection, special valves and intake design	12	16	42
1976-1977		Low temperature NO_x decomposition catalyst unit	3	3	6
1975	Alternative 3	Catalytic oxidation of exhaust HC and CO, air injection to assist catalytic unit	12	16	42
1976-1977		Exhaust gas recirculation increased to maximum for NO_x control. Modulation of recirculation	3	3	6

Table b

Model Year	Changes or Controls Added	Additional Cost Per New Vehicle (Dollars)	Total Cost Per Vehicle (Cumulative) (Dollars)
	Gasoline Trucks and Buses		
1967-69	None	0	0
1970-72	Lean operating carburetion, ignition timing changes	9	9
1973-74	Evaporative emission controls	32	41
1975-77	Exhaust gas recirculation for NO_x, plus air injection for HC, CO, 15-25% increased displacement	201	242
	Diesel Trucks and Buses		
1967-69	None	0	0
1970-74	Improved fuel injectors and careful operation to prevent excess smoke	0	0
1975-77	Extensive derating of operational horsepower range. Larger engines required for some applications compared to previous engines. Injection system design modifications.	1000	1000

Source: EPA, *The Economics of Clean Air*, March 1972.

C. Water Pollution

1. Limiting the area of raw, erodible earth exposed at a given time during the construction of a new highway

2. Construction of silt basins

3. Timely planting of erosion control grasses and plants

4. Limitations on fording streams

5. Reasonable restrictions for bridge and culvert construction

D. Noise Pollution

--The use of "quiet pavement surfaces and tires," although there may be a safety tradeoff.

E. Solid Waste

1. FHWA is cooperating with other government agencies on the problem of permanent disposal of autos.

2. Tires

a. Changing technology has lessened the use of old rubber in the manufacture of new rubber products, thus most old tires are not recylced

b. Some suggestions, however, for the reuse of tires have been put forward, including use as--

--reclaimed rubber
--fish havens
--fuel
--soil conditioners
--road surface filler
--chemicals (through destructive distillation)
--carbon black (through controlled burning)
--dock bumpers and other small quantity uses

F. Non Land-Use Changes That Will Reduce A Variety of Highway-Related Adverse Environmental Impacts

1. Introduction of staggered working hours.
2. Shift non-work trips to offpeak hours.
3. Arrange for carpooling.
4. Switch to small cars.
5. Regulatory control of parking.
6. Banning private autos from the central business district.
7. Raise tolls on toll bridges and tunnels during peak hours.
8. Lowering tolls on toll bridges and tunnels during off-peak hours.
9. Increasing central business district daytime parking rates.
10. Restrictions on curbside loading and unloading in congested areas.
11. Evening delivery by trucks in downtown areas.
12. Four-day work week.
13. Increased auto excise taxes, registration fees and annual license fees.
14. "Smog taxes"
15. Increase fuel taxes
16. Gasoline rationing.
17. Open the Federal Highway Trust Fund to allow grants for all land transportation modes, including new concepts like bikeway and people-mover systems, with funding allocated to states on a need basis.
18. With the exception of the last item above--which has numerous implications for land use and is consequently discussed in greater detail under Part IV--one study's estimate of the relative effectiveness of these various non-land-use factors in reducing adverse environmental impact is given in Exhibit C-VI.

Exhibit C-VI

TECHNIQUES FOR IMPROVING TRAFFIC FLOW, FOR REDUCING POLLUTION CONCENTRATION, AND FOR REDUCING AUTO TRAFFIC

Techniques for Improving Traffic Flow	Probable Effectiveness*
A. Freeways	
1. Reverse-lane operations	3
2. Driver advisory displays	1
3. Ramp control	2
4. Interchange design	2
B. Arterials	
1. Alinement	1
2. Widening intersections	3
3. Parking restrictions	2
4. Signal progression	2
5. Reversible lanes	3
6. Reversible one-way streets	3
7. Helicopter reports	2
C. Downtown Distribution	
1. Traffic responsive control	5
2. One-way street operations	3
3. Loading regulations	3
4. Pedestrian control	1
5. Traffic Operations Program to Increase Capacity and Safety (TOPICS)	5
Techniques for Reducing Pollution Concentration	
A. Staggered Work Hours	3
B. Roadway Concentrations	2
C. Cross-sections	2
D. Elevated, At-grade, Depressed Roadways	2
Techniques for Reducing Auto Traffic	
A. Transit Operations	
1. Bus lanes on city streets	2
2. Bus lanes on freeways	1
3. One-way streets with two-way buses	1
4. Park-ride, kiss-ride	3
5. Service improvements and cost reductions	2
B. Regulation	
1. Parking bans	4
2. Auto-free zones	4
3. Gasoline rationing	5
4. Idling restrictions	2
5. Four-day, forty-hour week	2
C. Pricing Policy	
1. Parking policy	2
2. Road-user tax	5
3. Gasoline tax	5
4. Car pool incentives	2
D. Planned Unit Development	2

Source: Alan Voorhees & Associates, Inc., Air Quality Considerations in Transportation and Urban Planning (December 1971), pp. 4-20.

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[*] Based on traffic volume affected, pollution reduction, population exposure, and any adverse pollution impact (e.g., more or longer trips likely to be induced, or likely to cause traffic congestion). Higher numbers indicate greater levels of effectiveness.

IV. LAND USE ALTERNATIVES FOR REDUCING ADVERSE ENVIRONMENTAL IMPACT

A. Exercise Site-Specific Design Control

1. Right-of-Way: Greater than minimum right-of-way widths needed for a highway may be acquired to allow for gentle slopes, to preserve existing plant growth along a highway, and to provide a buffer between the highway and surrounding land uses.

2. Cross-section: The use of liberal cross-section elements, wide lanes, and, where possible, wide medians improves not only the appearance of a highway, but, by reducing congestion, noise, and air pollution, its overall effect on the environment.

3. Grade: Emphasis on flat grades reduces the level of noise and air pollution.

4. Slopes: Flattening of slopes and rounding the intersections of slope planes presents a more natural appearance of roadsides and also reduces erosion.

5. View: By the use of such practices as curvilinear alignment, careful grading and selective clearing, a pleasing view from the road is provided motorists.

6. Depression: By the use of depressed roadways where feasible in urban areas, open spaces are increased and noise diminished.

7. Uniformity: The conscious effort to attain uniformity of design details throughout the highway systems, especially the Interstate system, makes highway facilities a more integrated whole and, thereby, a more aesthetic endeavor.

8. Structures: By appropriate use of structures, such as walls, tunnels, and bridges, unattractive deep cuts and fills are minimized. These structures can be designed to be positive contributions to the area. For example:

   a. New high strength steels and new designs have made it possible to build attractive deck bridges rather than bulky through truss bridges.

b. In multi-level interchanges or other elevated structures girders are fabricated so as to fit the curving alignment of ramps and roadways. The use of box girder design enhances the appearance of the underside of the structure.

c. Single column piers are used, where the width of the structure permits, to improve the graceful appearance of elevated highways.

d. The use of greater lateral clearances for piers and abutments presents a graceful open appearance of grade separation structures.

9. Cuts: Presplitting and serrating rock cut slopes improves the appearance of cuts that are necessary and reduces erosion.

10. Retaining Walls: Where walls are necessary because of restricted right-of-way or other reasons, various geometries and surface textures are used to harmonize with the surroundings. Arch configurations incorporating planting boxes and stone masonry have been used for this purpose.

11. Water Impoundment: Where appropriate highway departments, working in conjunction with State fish, wildlife, and conservation agencies, construct highways so that embankments serve as dams for the impounding of water to form ponds and small lakes.

12. Hydraulics: Hydraulic engineering is an essential element of highway design in order to keep the roadway usable and to prevent erosion or flooding. Measures considered include provision for dispersion or concentration of water, dissipation of energy, ponding, and silting basins. Drainage structures are installed flush with the median grade so that they do not present a hazard or detract from the appearance of the roadside. Several cities have participated in the construction of joint-use storm sewers built in conjunction with a highway project. Other cooperative projects include the construction of drainage and flood control measures as planned by other Federal, State and local agencies.

13. Lighting: The use of "high level", "high mast" or "tower" lighting is becoming increasingly common with some installations already in place and a number of additional projects in the design stage. This system utilizes the area lighting principles and is accomplished by the use of a relatively small number of tall poles or towers, each supporting several luminaires. Instead of concentrating the light on roadways and

adjacent surfaces, the entire interchange area is illuminated. A wider panoramic view of all portions of the interchange, rather typical of daytime conditions, is afforded the motorist. This is considered an aid in discerning the location and arrangement of all roadways, structures and other visual cues which guide the motorist. In addition to safety and economic advantages, this lighting technique should overcome the unsightly "forest of poles" which has frequently been criticized as presenting a cluttered interchange appearance during daylight hours.

14. Utilities: The use of highway rights-of-way by utilities is limited for aesthetic and safety reasons. Restrictions are particularly strict in scenic, park, and conservation areas. In some cases highway structures provide a way for utilities to cross a stream or some other natural feature.[1]

15. Improving Through-Flow of Traffic by:

    a. Installing left turn lanes at intersections.

    b. Providing bus turn-out lanes to facilitate passenger boarding without delaying traffic.

    c. Providing reversible flow traffic lanes.

    d. Building pedestrian overpasses.

    e. Reserving special lanes for buses during rush hour traffic.

16. Elevating or depressing the roadway to lessen direct impact on adjacent land use

17. Insulation of houses or buildings by installing storm windows on the side of buildings along freeway corridors

18. Screening highways with trees or walls although there is debate whether landscape plantings do much to reduce noise; one estimate is that plantings would have to be 300 to 500 feet in depth to cut noise levels in half

19. Excess acquisition of right-of-way and/or multi-use of right-of-way to maximize land use and minimize adverse impact

    a. Development of small parks, green strips, or play areas

    b. Special access to recreation areas (including access culverts under roads)

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[1] U.S. Department of Transportation, FHWA Highway Environmental Reference Book, November 1970, pp. 17-18.

c. Use of median strips for public transit

d. Highway embankment used to form lakes

e. Joint development of right-of-way for highway and airport extension

20. Title II of the Federal Aid-to-Highway Act adds Section 136 to Chapter 1, 23 U.S.C. providing for the control of junkyards, scrap metal processing facilities, and so forth.

a. All such facilities along interstate and federal-aid primary highways except those in industrial districts are to be screened such as by shrubbery or fencing, if they are within 1,000 feet of the right-of-way, and are visible from the roadway; if they cannot be effectively screened they are to be removed.

b. As in the removal of outdoor advertising, federal aid may pay 75 percent of the cost of removal.

c. In addition to providing guidance to the states for the screening or removal of junkyards, FHWA is cooperating with other government agencies on the problem of permanent disposal of autos.[1]

B. Changes in Urban Form

1. Changes that spread out population (e.g., deflecting population movement from large to small and medium-size urban areas) in order to reduce areas of congestion and increase the overall utilization of the highway network.

2. Changes aimed at concentrating population so as to maximize the feasibility of transit service or through the use of cluster development to reduce the requirements for roadbuilding (e.g., 108 lots under conventional subdivision require 5,400 linear feet of streets while a cluster development of 108 lots only requires 4,900 linear feet of streets).[2]

3. Development of fringe parking areas with links from public to private transit and truck terminals outside of urban centers.

4. Controlling land use directly adjacent to highways or in highway airspace (e.g., performance zoning or other controls on noise and emission-sensitive activities; restricting activities that can generate traffic in excess of the optimum capacity of the new highway).

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[1] FHWA Envrionmental Reference Book, 1970, p. 44.

[2] State of New York Environmental Plan 1973, p. 19.

C. Switch to Alternative Modes of Transportation

1. Fixed guideway systems for transit in large, relatively-dense urban centers.

2. Improved high speed rail systems for intercity travel in corridor regions:

   --Chicago-Milwaukee
   --Chicago-St. Louis
   --Los Angeles-San Diego
   --New York-Buffalo
   --Chicago-Los Angeles
   --Washington-Boston
   --Washington-New York

3. Instituting preferential treatment for buses on urban highway facilities, e.g., exclusive bus lanes, traffic control devices than can give priority to buses for movement through intersections and metering of traffic onto freeways.

4. Moving freight by unit trains, pipelines, etc., whenever possible.

5. Introduction of new transportation systems into land-use planning:

   a. Systems for major activity centers which employ continuously moving belts conveying pedestrians for short distances between commuter rail or rapid transit stations and through major shopping malls, of the use of continuously moving capsule transit systems or guideways suspended above city streets providing circulation throughout the central business district.

   b. Personal rapid transit consisting of small vehicles traveling over exclusive rights-of-way that are automatically routed from origin to destination over a network guideway system intended to serve low-to-medium population density areas of a metropolis.

   c. Dual-mode vehicle systems comprising small publicly or privately owned vehicles which can be individually driven and converted from street travel to travel on automatic guideway networks.

   d. Automated dual-mode bus systems that can operate on or off a fixed rail system enabling them to combine the high-speed capacity of rail transit with the flexibility and adaptability of a city bus.

   e. Pallet or ferry systems which use pallets to carry conventional automobiles, minibuses, or freight vehicles automatically on high-speed guideways.[1]

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[1] FHWA 1972 Highway Needs Report, p. II-106.

SUMMARY: HIGHWAY SITING

A. Timing

1. According to FHWA plans, between 50 and 75 percent of the construction needed to meet the 1990 highway needs is to be completed within the next seven years.

2. Although community opposition has been stopping new highway construction in many areas, there has been relatively limited expansion of alternative modes to meet transportation needs; the result is growing congestion on existing networks.

B. Magnitude

(That is, degree to which the adverse environmental impacts associated with highway siting can be controlled by nonland use versus land use variables.)

1. Air Pollution

a. Work is proceeding on pollution control devices in conjunction with EPA deadlines, although on a nationwide basis it is going to be several years before the impact is really felt.

b. Fixed guiderail systems have significantly less pollution than autos in terms of emissions/passenger mile and at most are estimated to increase SO_x emissions at stationary power sources by less than one percent.

--The lead time to construct new systems, however, is generally long (15 to 20 years).

--A relatively dense urban population of around 1 million people is needed if a transit system is to be truly viable.

c. New highways can have two types of impact on air pollution:

(1) To the extent it permits freer movement of traffic, it can help to reduce CO and hydrocarbons.

(2) To the degree that it attracts other types of land use (urban sprawl, gas stations, shopping centers) it can result in a net increase in ambient pollution levels.

(3) Increased speed along new highways also increase NOx emissions.

2. Noise Pollution

a. Elevating and lowering the roadways and the use of buffers and insulation can reduce the impacted area.

b. Quieter engines, braking systems, specially for trucks, are being introduced but the effect on reducing noise will be a gradual change.

c. Although buildings can be inspected, some control over adjacent land use for noise-sensitive activities seems advisable.

3. Water Pollution

a. Can be largely controlled through proper planning and engineering.

b. The tremendous quantities of salt used on roadways in the winter is a problem that does not appear to be undergoing any serious investigation vis-a-vis finding a solution with less adverse environmental impact.

4. Solid Waste

a. Suggestions have been made on ways of reusing bus and automobiles, but much remains to be done to bring about a widespread application of those techniques.

b. Reuse and/or proper disposal of crankcase oil deserves further consideration.

5. Land Consumption

a. Currently a large backlog of new highway projects is accumulating due to the extended Congressional debate over the use of Highway Trust Fund and the impoundment of funds.

b. If FHWA is able to get its construction program back on schedule, however, by 1990, an area approximately the size of West Virginia will be consumed for new road networks.

c. In a recent FHWA study to determine the impact of certain alternatives on reducing the requirements for new construction, the results showed (see Exhibit C-VII) that the greatest impact would come from expansion of alternative modes of transporting freight.

d. Secondary impact in terms of land consumption can reach major proportions in certain areas. However, recent studies indicate that the distribution of growth can be very uneven.

Exhibit C-VII

-Summary of the effect on arterial investment requirements of various alternatives

Alternative	*Change in arterial investments compared to base alternative
Increased urban transit patronage by 50 percent over current levels	4 percent decrease in total arterial investment requirements for all urbanized areas
Increased rural transit patronage by 50 percent over base forecast levels	.7 percent decrease in total arterial investment requirements for rural areas
Remove all goods movements over 200 miles via trucks from the highways	35 percent decrease in total arterial investment requirements for rural areas
Increase 1990 travel by 37 percent to correspond to historical growth rate	52 percent increase in nationwide total arterial investment requirements
Stagger working hours in large urbanized areas	3 percent decrease in total arterial investment requirements in areas with 1990 expected populations over one million

*Includes investment in new freeways, other new arterials, and periodic reconstruction of arterials.

Source: FHWA 1972 Highway Needs, p. II-90.

C. Irreversibility

Growth patterns established by highway networks are self-enforcing--stimulating more traffic and more shopping centers, gas stations, motels, drive-ins, restaurants, and similar activities which, in turn, create more congestion and demand for new road networks.

D. Possible Conflicts

1. Reduction or slowing of new highway development conflicts with the federal goal of providing balanced transportation.

2. Restricting the development of new highways without a corresponding increase in public transit service can result in greater congestion of existing networks and more concentration of adverse environmental impact.

3. Safety vs. Environment

a. "Soft" pavement innovations may reduce noise pollution but may also increase the safety hazard.

b. The opening of new arterials may reduce air pollution due to improved traffic flow, but lack of stop-and-go driving may aggravate safety problems related to monotony and driver fatigue.

E. Chain Effects

See C above.

F. Rural vs. Urban

1. Although over the near future FHWA is planning more new construction in urbanized areas than in rural areas, highway engineers traditionally have sought to lay out their routes in less densely occupied areas in order to avoid direct confrontation with community groups; the result has been increased consumption of parks and open space and agricultural land.

2. Recently FHWA conducted an investigation of the transportation implications associated with a number of nationwide growth alternatives; the conclusion reached was that in terms of cost (largely influenced by the price of land acquisition) and of total linear arterial miles required that the most favorable growth pattern would be to deflect population from large to small urban areas.[1]

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[1] FHWA, 1972 Highway Needs, p. II-71.

G. Concentration vs. Dispersion

1. The nation's highway network has been one, if not the most important factor in the dispersion of population up to the present.

2. Based on FHWA plans and program activities, the highway system will continue to encourage dispersion in the future.

H. Non-degradation

The population dispersion and urban sprawl phenomena associated with highway expansion have relatively serious implications with respect to degrading the quality of relatively clean air regions.

Appendix C
Part 2: PUBLIC TRANSIT

I. NEED

A. Factors Contributing to Increased Need for Public Transit.

1. Increasing urbanization of population with corresponding growth in motor vehicular congestion.

    a. Trends in population urbanization.

        (1) In 1970 approximately 80 percent of this nation's population of 200 million lived in urban areas.

        (2) By the year 2000 it is estimated that there will be 300 million Americans with 90 percent of those living in urban areas.

        (3) According to the report of the National Goals Research staff - as much as 85 percent of the net increase in population during the remainder of the century will be concentrated in the 12 largest metropolitan areas.

    b. Evidence in increasing traffic congestion within inner cities.

> "Between 1950 and the mid 1960's substantial improvements to the Northeast Corridor (NEC) network led to a more than 30 percent reduction in travel time between Boston and New York and 40 percent reduction between New York and Washington. More recently, intercity travel times have begun to increase again due to traffic congestion along the Boston-New York-Washington spine . . . it must be emphasized that congestion on these facilities generally does not result from intercity travel *per se*, but from local commuter and weekend traffic in and around the major metropolitan areas."[1]

2. Need for energy efficiency - In view of the current energy crisis and with the increased passenger load in sight, a trend towards more energy efficient means of transportation will be needed, i.e., we will want to move the maximum amount of people with the minimum amount of energy.

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[1] U.S. Department of Transportation, Recommendations for Northeast Corridor Transportation, (September, 1971) Vol. 1, p. 16.

a. As seen in Exhibit C-VIII for urban passenger traffic, mass transit systems are more than twice as efficient as automobiles.

Exhibit C-VIII

Energy and Price Data for Urban Passenger Transport

Mode	Energy (BTU/passenger mile)	Price (cents/passenger mile)
Mass transit	3,800	8.3
Automobile	8,100	9.6

Source: Science, March 30, 1973, Authors: Eric Hust & Moyers

b. Exhibit C-IX indicates that under high capacity conditions one track of rapid rail transit can move nearly eleven times as many people per hour as one lane of freeway (based on 180 passengers per car for a six car train with 1 1/2 minimum headways and two passengers per auto at 18 second headways).

3. Increasing demand to provide transportation services for disadvantaged members of society.

a. The poor.

(1) About 30 million people or 15 percent of the population can be classified as poor and cannot afford automobiles.

(2) The poor constitute 50 - 80 percent of total transit ridership.

(3) In 1970, 20 percent of households had no automobiles, the highest concentration of households are in low income brackets, older age groups, the urbanized northeast region and in central cities.

(4) Public transit remains as the poor's major mode of transportation; however, the 1963 census of transportation showed that the lowest economic groups has the highest percentage of workers with no public transportation available and the longest distance to travel to a transit line.

Exhibit C-IX

Passenger Capacities per Lane or Track in One Direction

Vehicle	Facility	Vehicles Or Trains per Lane or Track per Hour	Headway (min.)	Effective Capacity at Various Passengers per Vehicle 1.25	1.50	1.75	2.00
Private Automobile	City Street, Design Flow Rate	600	0.10	750	900	1,050	1,200
	City Street, Capacity	800	0.13	1,000	1,200	1,400	1,600
	Freeway, Design Flow Rate	1,500	0.04	1,875	2,250	2,265	3,000
	Freeway, Capacity	2,000	0.03	2,500	3,000	3,500	4,000
				Effective Passenger Capacity for Various Loading Ratios			
				75%	100%	125%	150%
Transit Bus (50 seats)	City Street	60	1.00	2.250	3,000	3,750	4,500
	City Street	90	0.67	3,375	4,500	5,625	6,750
	City Street or Freeway	120[a]	0.50	4,500	6,000	7,500	9,000
	Freeway	180[a]	0.33	6,750	9,000	11,250	13,500
	Freeway	240[a]	0.25	9,000	12,000	15,000	18,000
Bus Rapid Transit (Manual operation)	Busway, 50-seat buses	120	0.50	4,500	6,000	7,500	9,000
		240	0.25	9,000	12,000	15,000	18,000
		1,200[b]	0.05	45,000	60,000	75,000	90,000
Automated Bus Train	10-car train, 50-seat bus	20	3.00	7,500	10,000	12,500	15,000
		40	1.50	15,000	20,000	25,000	30,000
				Effective Passenger Capacity at Various Passengers per Car			
				100	120	150	180
Rail Rapid Transit Train	6-car train	20	3.00	12,000	14,400	18,000	21,600
		30	2.00	18,000	21,600	27,000	32,400
		40	1.50	24,000	28,800	36,000	43,200
	10-car train	20	3.00	20,000	24,000	30,000	36,000
		30	2.00	30,000	36,000	45,000	54,000
		40	1.50	40,000	48,000	60,000	72,000

Source: *Capacities and Limitations of Urban Transportation Modes*, Institute of Traffic Engineers, 1965 (except for Bus Rapid Transit and Automated Bus Train, which were calculated by Parsons, Brinckerhoff et al., in their St. Louis study).

Note: This table provides the elements necessary to determine the number of persons that may be accommodated per facility. Example of the number of persons carried in the peak direction on representative facilities are:

8-lane freeway 7,500 to 16,000 persons per hour.
2-track rail rapid transit with 6-car trains 12,000 to 43,000 persons per hour.

This table considers capacity only. A more complete comparison must consider demand and level of service which reflect convenience, flexibility of use, comfort, and many other factors.

[a] Capacity would be limited by design of bus turn outs and type of operation.

[b] Possible maximum if suitable terminal capacity off the busway can be provided.

(5) The orientation of most urban transit systems provides the highest level of service to downtown areas of cities. Although these central business districts provide the greatest proportion of job opportunities, there are expanding opportunities in the suburbs and "reverse commuter" trips have been slow to expand.

b. The Elderly.

(1) In 1970 there were 20 million Americans or nearly one tenth of the population was over the age of 65, of which about 62 percent lived in urban or suburban areas. It is estimated that by the year 2000 there will be 28 million elderly persons in this country.

(2) The elderly are the heaviest users of public transit.

(3) The elderly depend on public transit to provide access to basic necessities of life, a percentage of them have no viable alternatives.

(4) The elderly would use public transit more often if the fares were lower, since their demand for greater services is elastic.

c. The Young.

(1) The second greatest percentage of users of public transit are teenagers to young to drive.

(2) Teenagers represent 8 percent of labor force and encounter the same problem of access to jobs, shopping, etc., as do the elderly.

d. The Handicapped.

(1) Of the 6 million handicapped persons in the U.S., about 3 percent of the population, 63 percent of them live in urban or suburban areas and most are potential users of public transit.

(2) It is anticipated that over the next 15 year period, increases of more than 40 percent of the current population will experience heart disease impairment of upper and lower limbs and visual defects.

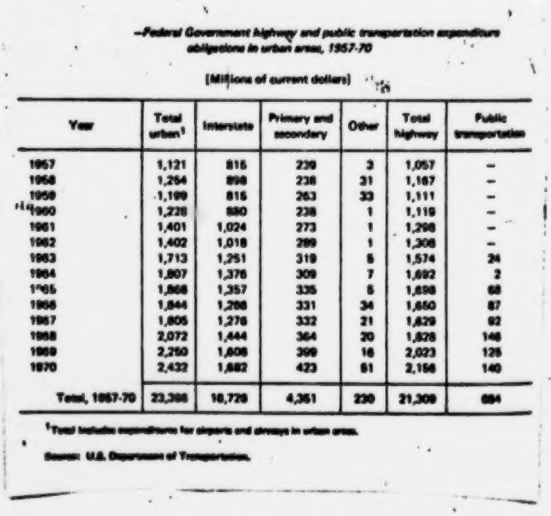
(3) Dependency on public transit by handicapped persons is relatively high. According to a Carnegie-Mellon survey done in Pittsburgh, 77 percent of the handicapped use either a bus or streetcar to get to work.

(4) A study by Abt Associates showed that for 30 percent of handicapped persons currently seeking employment - inadequate transportation was considered an obstacle to finding a job. Assuming that only handicapped persons in SMSA's would be likely to benefit, the study team estimated that a metropolitan transportation program designed to help the handicapped could return 189,000 people through-the nation to work.

B. Availability of Public Transit Systems

1. Development of urban transportation has emphasized the "rubber tire" transportation. Most of the Federal government transportation expenditures have been particularly highway-oriented (see Exhibit C-X).

Exhibit C-X



—*Federal Government highway and public transportation expenditure obligations in urban areas, 1957-70*

[Millions of current dollars]

Year	Total urban[1]	Interstate	Primary and secondary	Other	Total highway	Public transportation
1957	1,121	815	239	3	1,057	–
1958	1,264	898	238	31	1,167	–
1959	1,199	815	263	33	1,111	–
1960	1,228	880	238	1	1,119	–
1961	1,401	1,024	273	1	1,298	–
1962	1,402	1,018	289	1	1,308	–
1963	1,713	1,251	318	5	1,574	24
1964	1,807	1,376	309	7	1,692	2
1965	1,868	1,357	335	6	1,698	68
1966	1,844	1,285	331	34	1,650	87
1967	1,805	1,276	332	21	1,629	92
1968	2,072	1,444	364	20	1,828	146
1969	2,250	1,608	399	16	2,023	125
1970	2,432	1,682	423	61	2,166	140
Total, 1957-70	23,366	16,729	4,351	230	21,309	684

[1] Total includes expenditures for airports and airways in urban areas.

Source: U.S. Department of Transportation.

2. It is expected that under the terms of the urban transportation Federal assistance programs, the emphasis will continue to be on bus rather than rail systems.

   a. Bus systems require less money in terms of meeting local share requirements.

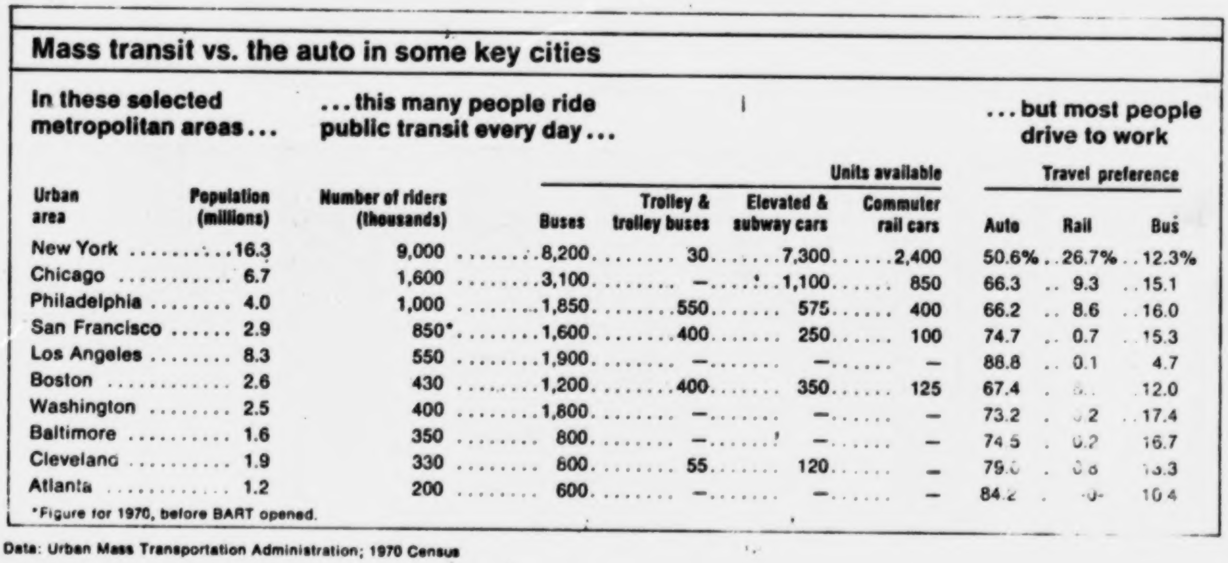
b. Bus systems can be implemented quickly, while rail systems can require 10 years or more from planning to operation.

c. Bus service is feasible in areas with densities of 5 to 10 families an acre; whereas fixed rail systems are best suited to areas characterized by a "corridor" settlement pattern and densities in excess of 30,000 persons per square mile.[1]

d. Only in the greater New York metropolitan area does the percentage of workers traveling by rail exceed that traveling by bus (see Exhibit C-XI).

e. Nevertheless, DOT investment programs call for investment of $62.3 billion in urban areas of 50,000 or more, of which 79 percent is projected to be used for rail transit.[2]

Exhibit C-XI



Mass transit vs. the auto in some key cities

In these selected metropolitan areas...		...this many people ride public transit every day...					...but most people drive to work		
			Units available				Travel preference		
Urban area	Population (millions)	Number of riders (thousands)	Buses	Trolley & trolley buses	Elevated & subway cars	Commuter rail cars	Auto	Rail	Bus
New York	16.3	9,000	8,200	30	7,300	2,400	50.6%	26.7%	12.3%
Chicago	6.7	1,600	3,100	—	1,100	850	66.3	9.3	15.1
Philadelphia	4.0	1,000	1,850	550	575	400	66.2	8.6	16.0
San Francisco	2.9	850*	1,600	400	250	100	74.7	0.7	15.3
Los Angeles	8.3	550	1,900	—	—	—	88.8	0.1	4.7
Boston	2.6	430	1,200	400	350	125	67.4	[illegible]	12.0
Washington	2.5	400	1,800	—	—	—	73.2	0.2	17.4
Baltimore	1.6	350	800	—	—	—	74.5	0.2	16.7
Cleveland	1.9	330	800	55	120	—	79.0	3.6	13.3
Atlanta	1.2	200	600	—	—	—	84.2	-0-	10.4

*Figure for 1970, before BART opened.

Data: Urban Mass Transportation Administration; 1970 Census

3. The total number of bus, rail and trolley coach systems has been declining over the last decade, largely as a result of declining private ownership (see Exhibit C-XII).

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[1] Wilbur Smith & Associates. The Potential for Bus Rapid Transit (1970), p. 26, and New York Times (August 19, 1971), p. 26.

[2] U. S. Department of Transportation, 1972 Transportation Needs Report, Table V-3.

Exhibit C-XII

—Number of bus, rail, and trolley coach systems, by ownership, December 31, 1959, to December 31, 1970

Year	Total	Private	Public
	Number		
1959	1,225	1,173	52
1964	1,152	1,073	79
1967	1,138	1,040	98
1968	1,094	980	114
1969	1,086	955	131
1970	1,079	938	141
	Change		
1959-64 (average per year)	−15	−20	+5
1965-67 (average per year)	−4	−11	+6
1968	−44	−60	+16
1969	−8	−25	+17
1970	−7	−17	+10
Total change, 1959-70	−146	−235	+89

Source: American Transit Association, Supplement to the "1970-71 Transit Fact Book."

4. Local transit is forecast to grow at 2.0 percent per year between 1970 - 1990. Exhibit C-XIII shows projected growth in transit use by city-size.

Exhibit C-XIII

—Forecasted percent increase in average weekday person trips by mode and 1990 population group (1970-90)[1]

Mode	Entire country	Over 2 million	1-2 million	500,000-1,000,000	250,000-500,000	100,000-250,000	50,000-100,000
Bus	29.8	13.9	48.8	107.2	62.8	71.0	138.5
Rapid rail	60.7	51.4	(2)	(3)	(4)	0.0	0.0
Commuter railroad	23.6	23.2	0.0	(5)	0.0	0.0	0.0
Subtotal, transit	38.5	27.7	87.3	119.0	65.7	71.0	138.5
Automobile	75.0	65.5	73.8	90.1	114.6	71.4	73.8
Taxi	41.2	10.5	146.7	43.0	90.5	53.1	65.7
Subtotal, automobile and taxi	74.5	64.6	75.1	80.8	114.2	71.5	73.7
Total	71.1	59.5	75.6	91.1	112.9	71.3	74.7

[1] Although not all urban areas reported 1970 and 1990 trips, the years were sufficiently close so as to approximate trips for those periods.

[2] 3 urban area forecasted rail rapid transit travel but had none in base year.

[3] 4 urban area forecasted rail rapid transit travel but had none in base year.

[4] 1 urban area forecasted rail rapid transit travel but had none in base year.

[5] 1 urban area forecasted commuter rail travel but had none in base year.

Source: Reports from States and urban areas, 1972 National Transportation Study, U.S. Department of Transportation.

a. Public policies are expected to help produce this turnabout:

(1) Localities are incorporating public transit programs into transportation control plans for air quality implementation plans.

(2) Spurred by the fuel shortage, President Nixon proposed in his State of the Union address (January 31, 1974) an increase of nearly 50 percent in Federal assistance to urban mass transit.

(3) Administration programs call for a new unified transportation Assistance Program (UTAP) to consolidate existing programs and add $3 billion in new money, of which an unspecified amount will be added to cover operating assistance for transit systems.

b. Better marketing and technology (e.g., Bay Area Rapid Transit System in San Francisco) will affect a wide range of improvements in comfort, cost and convenience, all of which are important in attracting and keeping passengers.

III. LAND USE AND ENVIRONMENTAL IMPACT

A. Primary Impact

1. Land Utilization

a. Highly efficient utilization of a minimum amount of valuable urban land.

(1) The quantity of land absorbed for a transit right-of-way is 1/3 - 1/2 that needed for an urban freeway, excluding freeway needs for feeder lanes or parking.

(2) A new six mile stretch of rapid transit in Boston built on the existing right-of-way of the New Haven Railroad is expected to carry 35,000 passengers per day by 1975 at virtually no cost to existing land use. If the same amount of people commuted by highway it would require six to eight lanes of new paved surface and cause a heavy absorption of land in the central business district.

(3) A six lane urban freeway would require widths from 90 - 150 feet for right-of-way, while modern rapid transit double track electric structure built on "T" supports requires 28 feet of right-of-way.

b. Increased availability of urban land area.

(1) In some downtown areas the percentage of downtown surface devoted to the moving and storage of automobiles is as high as 65 percent.

(2) In one project it was concluded that if a transit system were not in operation, the central business district would require 6,000 additional parking spaces, using from 1.8 million to 2.4 million square feet.

(3) Due to the concentration of apartments, office buildings and retail stores in the vicinity of rapid transit corridors, more efficient use is made of the existing supply of urban land. According to the Los Angeles Planning Commission, which examined several land use plans, only 78 percent of available urban land was required for homes, work and shopping as compared to a requirement of 87 percent of urban land for the same facilities where there was no rapid transit system.

(4) In Toronto, land use studies showed that land with extensive access to rapid transit could potentially accommodate 10 percent greater population density than with highways on equal land areas.

c. Reduced traffic congestion.

--Every 50 persons diverted to public transit represent a reduction of approximately 30 automobiles in the traffic stream, contributing to better traffic flow.

2. Factors Contributing to Reduction in Air Pollution -

a. A decreased use of automobiles, a primary source of air pollution in the country, as the modal split changes in favor of public transit.

(1) In terms of air quality increased use of public transit offers a tremendous advantage over automobiles. Exhibit C-XIV compares emissions from automobiles with 1976 pollution control devices to the present day emissions from the Metroliner ope rations.

Exhibit C-XIV
REPRESENTATIVE TRANSPORTATION EMISSIONS*

MODE	SPEED (MPH)	UHC	CO	NOx	SOx	PART.
AUTO (1976)	60	.27	2.21	.26	-	-
METROLINER	125	-	-	.22/.11**	.08/.04**	.01/.006**
	160	-	-	.33/.17**	.12/.06**	.02/.01**

* Expressed in Units of Lbs. Per Thousand seat-mile.

** These figures showing emissions from the electric generating plan providing the motive power reflect a range from highly-controlled fossil fuel with 1% fuel, 50% coal, and 50% oil (on the left), to 50% nuclear and 50% highly-controlled fossil fuel (on the right).

Source: Strategic Planning Division, Office of Systems Analysis & Information, Assistant Secretary for Policy & International Affairs, Department of Transportation, 1972.

(2) In Chicago it has been estimated that a proposed loop system improvement by the Chicago Transit Authority will by 1990 produce the following daily reduction in vehicle pollutant emissions in the Chicago area (equivalent to 12% of the city's total):

	metric tons/day
carbon monoxide	49.0
hydrocarbons	7.0
nitrogen oxides	7.7
sulfur dioxide	0.7
particulates	2.0

1 metric ton = 2200 lbs.

b. More efficient combustion by automobiles resulting from better flowing traffic.

  - Most carbon monoxide is released during acceleration, hence intermittent driving in stop-and-go city traffic results in a significantly greater release of pollutants than uncongested and steady driving.

3. Factors Contributing to a Reduction in Noise Pollution.

  a. Reduction in traffic noise generated -

    - The same number of people can be moved with a lower community noise exposure by a subway system than by any other form of transportation (see Exhibit C-XV).

  b. Technological improvements in public transit systems themselves to reduce the noise generated by them.

    (1) Bay Area Rapid Transit improvements minimizing noise level are such that a car interior noise shall not exceed 60 dba.

    (2) Typical noise levels range from 95 - 102 dba at 50 feet from Chicago Transit Authority elevated lines; noise levels 10 - 17 dba above 85 dba maximum for a single event passed by noise level criterion (50 feet distance) in commercial areas, as proposed by the Institute for Rapid Transit.

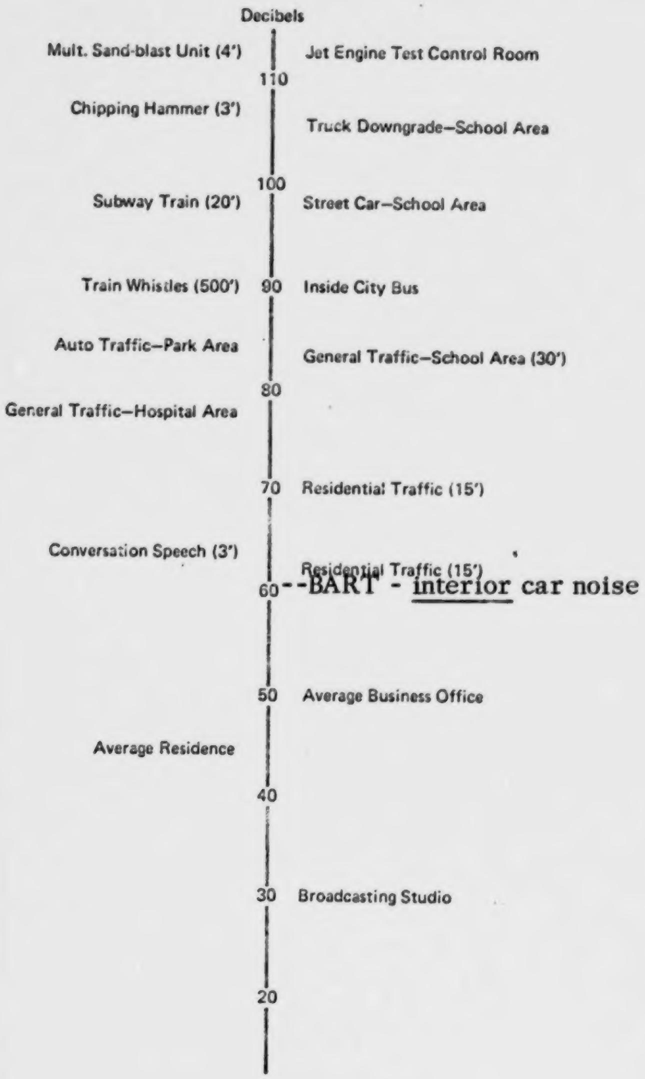
4. Savings in Energy and Petroleum Consumption.

  a. Increased emphasis on petroleum will divert passengers from petroleum consuming vehicles to railed vehicles which can transport passengers at a lower energy cost per passenger mile.

  b. In 1970, transportation consumed 16.4 quadrillion BTU's (approximately 25 percent of the total energy used in the country). Automobiles consumed more than 55 percent of the transportation energy in 1970, while trucks, the second largest users consumed about 21 percent of the total.

  c. Energy efficiency for automobiles in urban areas is 7 passenger miles per gallon of gas, compared to 40 for urban buses and 120 for commuter trains.

Exhibit C-XV



Selected Sound Levels. Source: M. Kamrass, J. Crane, P. Hughes, and E. Parker, *Concepts for Evaluating Center City Transportation Programs and Projects*, Urban Mass. Transportation Project, December 1969, p. 39.

Appendix D
RESIDENTIAL DEVELOPMENT
(Environmental Impacts of Alternative Housing Types)

I. NEEDS

A. Types of Residential Housing[1]

1. Single-family: conventional - three units/acre[2]
    - a. Each dwelling unit located in its own isolated structure
    - b. Adequate light, air and room for gardening, play, parking and other outdoor uses
    - c. Shielded from noise and view
    - d. Imposes low densities which encourage city sprawl, poor transportation, sparse community services, and loss of rural land
2. Town House (10 units/acre)
    - a. Three or more units attached side by side (row houses)
    - b. Most space at lowest cost, cheapest to maintain and heat
    - c. Greater privacy than single or two-family house on small lot, more efficient use of land
    - d. Higher densities enable improved transportation and community services
    - e. Noise control may be problematic
3. Walk-Up Apartments (15 units/acre)
    - a. Single-story units stacked one above the other to a height of two, three, or rarely four or more stories, and accessible by common stairs
    - b. Convenience of apartment living at low densities

---

[1] Source: Kevin Lynch, Site Planning, 1972, p. 272.

[2] Source for densities: Real Estate Research Corporation, Economic and Environmental Effects of Alternative Development Patterns, August 1973.

  c. 35% of all new housing now in apartment dwellings

  d. Units may be grouped around stairs so each one has good light and cross-ventilation

4. High-Rise Apartments (30 units/acre)

  a. Units stacked to greater heights and served by elevators

  b. Highest densities, so more efficient transportation and community services possible

  c. Better view of the city, but problems of access to the ground, parking, recreation, and ground level circulation

  d. Two major types:

    (1.) Tower block - better light and air, visually more appealing, more expensive to build than slab

    (2.) Slab - central corridor prevents cross-ventilation of units, system of exterior gallery raises problems of privacy, danger to children, and exposure to weather; often casts deep shadows or adjusts clumsily to terrain; possible problems of winds, reflections, radiation or noise

5. Mobile Homes

  a. Account for 20% of all new housing units produced in the U.S.

  b. Can be moved most anywhere, often little concern for site arrangement and efficient access to power and utility sources

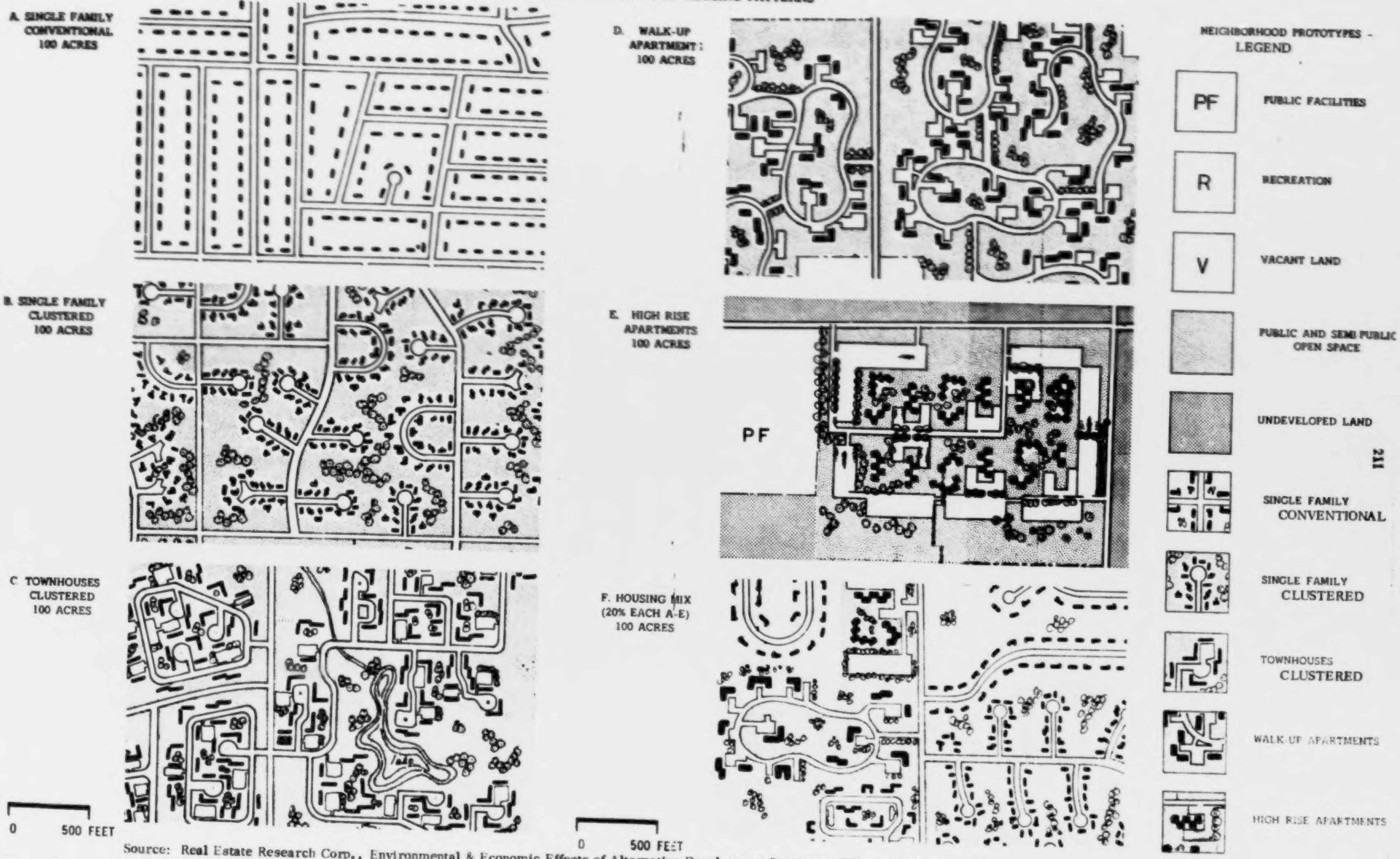
  c. Prefabricated house, outgrowth of trailers

  d. Inexpensive and easy to buy and maintain, limited resale value

  e. Limited information available on environmental effects of mobile homes. The rapidly growing popularity of mobile homes makes this an area of possible investigation for EPA.

EXHIBIT D-I

COMPARISON OF NEIGHBORHOOD HOUSING PATTERNS


A. SINGLE FAMILY CONVENTIONAL 100 ACRES
B. SINGLE FAMILY CLUSTERED 100 ACRES
C. TOWNHOUSES CLUSTERED 100 ACRES
0 500 FEET
D. WALK-UP APARTMENT: 100 ACRES
E. HIGH RISE APARTMENTS 100 ACRES
PF
F. HOUSING MIX (20% EACH A-E) 100 ACRES
0 500 FEET
NEIGHBORHOOD PROTOTYPES - LEGEND
PF PUBLIC FACILITIES
R RECREATION
V VACANT LAND
PUBLIC AND SEMI PUBLIC OPEN SPACE
UNDEVELOPED LAND
SINGLE FAMILY CONVENTIONAL
SINGLE FAMILY CLUSTERED
TOWNHOUSES CLUSTERED
WALK UP APARTMENTS
HIGH RISE APARTMENTS

Source: Real Estate Research Corp., Environmental & Economic Effects of Alternative Development Patterns, 1973, Task II, Figure 7.

B. Presently Growing Trends

1. Condominium and cooperative ownership
2. New towns
3. Planned unit development
4. Prefabricated housing units

C. New Towns

1. Employs entire range of residential housing types: single-family to high-rise apartment, subsidized housing to condominium and cooperative ownership.

2. Number of acres of land in new towns, by region:

Exhibit D-II

	Region	Acres
a.	New York Metropolitan Region	28,228+
b.	Eastern Region	91,316+
c.	Southern Region	1,153,754+
d.	Central Region	54,406+
e.	Western Region	608,145
	Total Acreage for New Towns	1,935,849

Source: U.S. Postal Service, 1973.

D. Density

Exhibit D-III

1. DENSITIES BY RESIDENTIAL TYPE

Type of unit	*Floor area ratio*	*Families per net res. acre*	*Families per neighborhood acre*
Single-family	Up to 0.2	Up to 8	5
Two-family	0.3	10–12	7
Row	0.5	16–20	12
Combined flats and row	0.75	25–30	16
Three-story walk-up	1.0	40–45	20
Six-story elevator	1.4	65–75	28
Thirteen-story elevator	1.8	85–95	31

Source: Kevin Lynch, Site Planning, 1972, p. 315.

2. Density Thresholds

Exhibit D-IV

Families Per Acre	Problem
Under 12 families per acre	Maintenance of grounds, Community services
12 families per acre or more	Noise control; privacy
20 families per acre	[Point of maximum economy]
20 families per acre or more	Outdoor space, direct access from all units to ground, easy surface parking, external identification of units
45 families per acre or more	Sense of visual intimacy or "human scale"
80 families per acre or more	Parking space, area for landscaping, recreation area
100 families per acre or more	Congested circulation, smaller size of dwelling units.

Source: Kevin Lynch, Site Planning, 1972, p. 316.

E. Household Development

1. By 1990, 90 million households will be formed, an increase of 27 million households from 1970.[1] From now until 1985, over 27,000 new households are anticipated each week.[2]

2. 9,537,342 persons are slated for new towns, new communities, or large scale development.[3]

3. The 1970 census showed that for the first time population in the U.S. suburbs (37%) is greater than that in either the central cities (31%) or the non-metropolitan parts of the country.[4]

F. Land Consumption

1. As more people live in metropolitan areas, these regions are expected to consume increasing amounts of land.

    a. The latest U.S. Census Bureau report shows a one-third increase in land considered urban during the 1960's.

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[1] Wm. Reilly, Editor, Use of Land, 1973, p. 80.

[2] Ibid, p. 77.

[3] U.S. Postal Service, 1973.

[4] 1972 World Almanac, p. 145.

b. The land area of urban regions is expected to increase from 196,958 sq. miles in 1960 to 486,902 sq. miles in the year 2000.

Exhibit D-V

Population and Land Area of Urban Regions: 1920-2000

	1920	1940	1960	1980[a]	2000[a]
Number of urban regions	10	10	16	24	25
Population *millions*	35.6	53.9	100.6	164.6	219.7
percent of total U.S. population	33.6	40.8	56.1	73.4	83.1
Land area[b] *sq. miles*	60,972	94,999	196,958	395,138	486,902
percent of total U.S. land area[c]	2.1	3.2	6.6	13.3	16.4
Gross population density *people per sq. mile*	584	568	511	417	451

[a] Based on Census Bureau series E population projection (based on a fertility assumption of 2.1 births per woman)

[b] Excludes urban region of Oahu Island, Hawaii

[c] Coterminous U.S. excluding Alaska and Hawaii

Source: Jerome Pickard, "U.S. Metropolitan Growth and Expansion 1970-2000 with Population Projections," prepared for the Commission on Population Growth and the American Future at the Urban Land Institute, Washington, D.C., December, 1971

2. Exhibit D-VI describes comparative acreage (per 10,000 housing units) required for community development patterns and for vacant areas.

   a. Low density sprawl requires the most land for residential use. (667 more acres than low density planned).

   b. Low density planned has 260 acres more land for recreation than low density sprawl.

   c. Low density sprawl requires the most acreage developed for all purposes; (477 more acres than low density planned).

   d. Low density planned has 477 more acres of vacant land than low density sprawl.

Exhibit D-VI
COMMUNITY LAND BUDGET

For 10,000 Housing Units	Units/Acre	Community Development Pattern (Acres) I Planned Mix	II Combination Mix 50% PUD 50% Sprawl	III Sprawl Mix	IV Low Density Planned	V Low Density Sprawl	VI High Density Planned
DEVELOPED AREA							
1. Residential[a]							
A. Single, Conventional	3.0	660	660	660	833	2,500	-
B. Single, Clustered	5.0	400	400	400	1,500	500	200
C. Townhouse, Clustered	10.0	200	200	200	-	-	200
D. Walk-Up Apartment	15.0	130	130	130	-	-	200
E. High-Rise Apartment	30.0	60	60	60	-	-	133
Subtotal		1,450	1,450	1,450	2,333	3,000	733
2. Open Space/Recreation[b]		660	530	400	660	400	660
3. Schools[c]							
Elementary		170	170	170	170	170	170
Secondary		90	90	90	90	90	90
Subtotal		260	260	260	260	260	260
4. Other Public Facilities[d]		140	140	140	140	140	140
5. Transportation[e]							
Neighborhood R.O.W.		450	450	450	640	710	300
Expressway		80	80	80	80	80	80
TOTAL DEVELOPED AREA		3,040	2,910	2,780	4,113	4,590	2,173
VACANT AREA							
1. Improved, Land[f/g]		130	180	235	175	390	90
Improved, R.O.W.		22	33	43	31	69	19
Subtotal		152	213	278	206	459	109
2. Semi-Improved, Land[f/g]		435	878	1,320	585	903	310
Semi-Improved, R.O.W.		21	44	70	32	48	16
Subtotal		456	922	1,390	617	951	326
3. Unimproved, Land[f/g]		2,235	1,857	1,474	1,010	0	3,220
Unimproved, R.O.W.		117	98	78	54	0	172
Subtotal		2,352	1,955	1,552	1,064	0	3,392
TOTAL VACANT LAND		2,960	3,090	3,220	1,887	1,410	3,827
TOTAL COMMUNITY ACREAGE		6,000	6,000	6,000	6,000	6,000	6,000

Notes:

[a] Source: Real Estate Research Corporation. Extrapolated from neighborhood land budget.

[b] Derived from ASPO, Standards for Outdoor Recreational Areas (ref. no. 02-001).

[c] Derived from Council of Educational Facility Planners, Guide for Planning Educational Facilities.

[d] Assumes 10 acres + 1 acre/100 pupils for elementary and 30 acres + 1 acre/100 pupils for second. Source: Real Estate Research Corporation.

[e] Neighborhood right-of-way acreage extrapolated from neighborhood land budget. Expressway right-of-way width is 220' for a three mile length.

[f] Vacant Areas - Total Acreage

	I	II	III	IV	V	VI
Vacant Improved % of developed acreage	5%	7.5%	10%	5%	10%	5%
Vacant Semi-Improved % of developed acreage	15%	32.5%	50%	15%	Balance of 6,000 acres	15%
Vacant Unimproved % of developed acreage	Balance of 6,000 acres	Balance of 6,000 acres	Balance of 6,000 acres	Balance of 6,000 acres	None	Balance of 6,000 acres

[g] Vacant Areas - Right-of-Way

	I	II	III	IV	V	VI
Percent of Vacant Improved Acreage	15%	15%	15%	15%	15%	15%
Percent of Vacant Semi-Improved Acreage	5%	5%	5%	5%	5%	5%
Percent of Vacant Unimproved Acreage	5%	5%	5%	5%	None	5%

II. ENVIRONMENTAL IMPACT

A. Direct Impact

1. Air Pollution

a. Exhibit D-VII shows emissions per neighborhood from natural gas, pounds per day.

b. In all cases, single family homes pollute the air over twice as much as high-rise apartments.

c. Over the period of a year, for example, single-family homes emit 14,892 more pounds of NO_x and 5,110 pounds of HC than high-rise apartments. (See Exhibit D-VII.)

d. Urban areas influence local weather and air pollution distribution in the following ways:[1]

(1) Winds: Man-made structures reduce the wind speed and channel the flow through streets that lie along the general wind direction. Under some conditions, pollutants become distributed in waffle-shaped patterns following the city plan of streets. Peak concentrations may be lowered.

(2) Temperature: Buildings retain incident daytime heat and re-radiate at night to the surrounding air, thus acting to warm it through a layer that is several times higher than the urban skyline.

(3) Turbulence: The higher temperature, rougher profile, blocking of wind, and net influx of air into the city act to increase vertical motions of the air above the city. Pollutants that might otherwide accumulate under a nocturnal temperature inversion become distributed through the thicker layer of atmospheric mixing above the city.

(4) Other Effects: The above effects, plus the added presence of particulate matter, act to increase cloudiness and precipitation near a city, particularly downwind from it; precipitation is effective in removing pollutants from the air.

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[1] Source: EPA, Guide for Control of Pollution Episodes.

Exhibit D-VII
NEIGHBORHOOD DEVELOPMENT PATTERNS
AIR POLLUTION

	Housing Pattern (1,000 Units)					
	A	B	C	D	E	F
	Single-Family Conventional	Single-Family Clustered	Townhouse Clustered	Walk-Up Apartment	High-Rise Apartment	Housing Mix (20 Percent Each A - E)
Pollutants from Residential Heating (pounds per day) 1/2/3/						
Particulates	10.80	10.80	9.00	6.30	4.68	8.32
SO_x	.36	.36	.30	.21	.16	.28
CO	.24	.24	.20	.14	.10	.18
HC	24.00	24.00	20.00	14.00	10.00	18.40
NO_x	72.00	72.00	60.00	42.00	31.20	55.44

Notes:

1/ Assumes 67% of dwelling units use natural gas heat; 33% use electric heat.
Source: U. S. Department of Commerce, C-25 Construction Reports (ref. no. 01-152).

2/ Residential natural gas consumption assumed to be:

Housing Type	Consumption (Cubic Feet per Day)
A	600,000
B	600,000
C	500,000
D	350,000
E	260,000

Consumption amount is based on average winter month consumption assuming 80% of total annual consumption occurs in five winter months.
Source: Hittman Associates, Residential Energy Consumption Vols. I and II (ref. nos. 14-008 and 14-009).

3/ Emission quantities from residential natural gas consumption assumed to be:

Pollutant	Amount (Pounds per 10^6 Cubic Feet)
Particulates	18.0
SO_x	0.6
CO	0.4
HC	40.0
NO_x	120.0

Source: Kaman Services Corp., Land Use Planning In Pikes Peak Area (ref. no. 17-036).

e. Although incidence of auto use per household declines as density increases, auto emissions are more concentrated as size of communities increase.

f. Exhibit D-VIII describes emissions per community from automobiles. The largest concentration of carbon monoxide (as well as other auto emissions) occurs in low density sprawl communities, with an increase of 733,234 pounds per year emitted compared to high density planned communities.

2. Water Pollution

a. The capital investment costs of supplying water to high-rise apartments is significantly lower than for single-family detached houses ($447,092 per thousand units versus $2,443,486). Ten thousand units of a high density planned community, in addition, require $9,607,274 for water supply, compared to $27,236,468 for a low density sprawl community.

b. Housing and community development patterns can also have a differential impact on water pollution, with the lower levels being attributable to higher density patterns (see Exhibits IX and X).

c. It has long been recognized that urban development in a watershed causes change in the streamflow regimen. The urbanization process produces four effects on the hydrology of the area. They are:

(1) Changes in the peak flow characteristics

(2) Changes in the total runoff and frequency of flooding

(3) Possible reduction of groundwater recharge

(4) Enlargement and degradation of the stream channel

Exhibit D-VIII
COMMUNITY DEVELOPMENT PATTERNS
AIR POLLUTION

	Community Development Pattern (10,000 Units)					
	I	II	III	IV	V	VI
	Planned Mix	Combination Mix 50 Percent PUD, 50 Percent Sprawl	Sprawl Mix	Low Density Planned	Low Density Sprawl	High Density Planned
Pollutants from Private Automobiles 1/2/ (pounds per day)						
CO	2,526.07	3,043.28	3,627.95	3,283.14	4,040.21	2,031.35
HC	304.61	366.98	437.49	395.91	487.20	244.96
NO_x	297.18	358.03	426.82	386.25	475.32	238.98
Pollutants from Private Automobiles per Developed Acre 3/ (pounds per day)						
CO	.8309	1.0458	1.3050	.7982	.8802	.9348
HC	.1002	.1261	.1574	.0963	.1061	.1127
NO_x	.0978	.1230	.1535	.0939	.1036	.1100
Pollutants from Residential Heating 4/ (pounds per day)						
Particulates	83.16	83.16	83.16	108.00	108.00	66.42
SO_x	2.78	2.78	2.78	3.60	3.60	2.23
CO	1.84	1.84	1.84	2.40	2.40	1.46
HC	184.00	184.00	184.00	240.00	240.00	146.00
NO_x	554.40	554.40	554.40	720.00	720.00	442.80
Pollutants from Residential Heating per Developed Acre 3/ (pounds per day)						
Particulates	.0274	.0286	.0299	.0263	.0235	.0306
SO_x	.0009	.0010	.0010	.0009	.0008	.0010
CO	.0006	.0006	.0007	.0006	.0005	.0007
HC	.0605	.0632	.0662	.0584	.0523	.0672
NO_x	.1823	.1905	.1992	.1751	.1569	.2038

Source: Real Estate Research Corp., op. cit., Task II, p. 146.

Exhibit D-IX
NEIGHBORHOOD DEVELOPMENT PATTERNS
WATER POLLUTION AND EROSION

	Housing Pattern (1,000 Units)					
	A	B	C	D	E	F
Sediment from Erosion	Single-Family Conventional	Single-Family Clustered	Townhouse Clustered	Walk-Up Apartment	High-Rise Apartment	Housing Mix (20 Percent Each A - E)
Average Annual Volume during Development Period (Tons per Year) 1/	597.32	426.73	282.09	203.76	115.81	325.34
Pollutants from Storm Run-Off						
Total Volume (Liters per Year) 2/	818,986,080	606,529,440	459,180,480	339,245,280	171,336,000	476,314,080
Pollutants (Kilograms per Year) 3/						
BOD	19,082.4	14,132.1	10,698.9	7,904.4	3,992.1	11,098.1
COD	51,596.1	38,211.4	28,928.4	21,372.5	10,794.2	30,007.8
N	2,211.3	1,637.6	1,239.8	915.0	462.6	1,286.1
P	655.2	485.2	367.3	271.4	137.1	381.1
S. Solids	818,986.1	606,529.4	459,180.5	339,245.3	171,136.0	476,314.1
FCB (Number x 10^{-6} per Year)	995,887.0	737,539.0	558,363.0	412,522.0	208,344.0	579,197.0

Notes:

1/ Volume of sediment calculated as follows:

a. Volumes of sediment (tons per square mile per year) assumed as follows:

Land Use	Sediment
Wooded areas	100
Agricultural Areas	300
Vacant Land and Permanent Open Space	200
Developed, Urbanized Areas	700
Construction Areas	2,300

Source: Interstate Commission of the Potomac River Basin, Land Run-Off (ref. no. 15-019).

b. Average duration of construction activity assumed to be .5 years.

c. Areas derived from neighborhood prototype land budgets.

d. Average annual volume of sediment during development period calculated according to following:

Vacant or Permanent Open Space Areas (square miles) x 200 tons per square mile per year x 10 years
Developed Areas (square miles) x 700 tons per square mile per year x 10 years
Developed Areas (under construction) (square miles) x 2,300 tons per square mile per year x .5 year
Total Volume of Sediment (in tons) during Development Period, 10 years
Total Volume of Sediment (in tons, 10 years) ÷ 10 = Average Annual Volume of Sediment (in tons)

2/ Volume of storm run-off calculated by use of rational formula as follows:

a. Coefficients of run-off assumed as follows:

Land Use	Run-Off Coefficient
Residential	
Housing Types A, B	.40
Housing Type C	.50
Housing Types D, E	.60
Open Space/Recreation	.20
Schools	.25
Other Public Facilities	.60
Transportation	.60
Vacant	.20

Source: Seelye, Design (ref. no. 09-015).

b. Assume annual precipitation is 40 inches.

Source: Seelye, Design (ref. no. 09-015).

c. Areas derived from neighborhood prototype land budgets.

Exhibit D-X
COMMUNITY DEVELOPMENT PATTERNS
WATER POLLUTION AND EROSION

	Community Development Pattern (10,000 Units)					
	I Planned Mix	II Combination Mix 50 Percent PUD, 50 Percent Sprawl	III Sprawl Mix	IV Low Density Planned	V Low Density Sprawl	VI High Density Planned
Sediment from Erosion						
Average annual volume during development period (tons per year) 1/	4469.53	4450.31	4431.09	5500.62	6170.39	3636.40
Pollutants from Sewage Effluent						
Total Volume (Liters per Year) 2/	4,559,032,500	Same as 1.	Same as 1.	Same as 1.	Same as 1.	Same as 1.
Pollutants (Kilograms per Year) 3/						
BOD	22,795.1	Same as 1.	Same as 1.	Same as 1.	Same as 1.	Same as 1.
COD	191,479.4					
N	77,503.6					
P	4,459.0					
S.S.	9,118.0					
FCB (Number x 10^{-6} per Year)	100% Removal					
Pollutants from Storm Run-Off						
Total Volume (Liters per Year) 4/	7,785,507,840	7,809,494,880	7,836,208,640	8,511,972,480	9,176,756,160	7,141,284,480
Pollutants (Kilograms per Year) 5/						
BOD	181,402.3	181,961.2	182,600.0	198,329.0	213,818.4	166,391.9
COD	490,487.0	491,998.1	493,725.2	536,254.2	578,135.6	449,900.9
N	21,020.8	21,085.6	21,159.6	22,982.3	24,777.2	19,281.4
P	6,228.4	6,247.6	6,269.5	6,809.5	7,341.4	5,713.0
S.S.	7,785,507.8	7,809,494.9	7,836,908.6	8,511,972.5	9,176,756.2	7,141,284.5
FCB (Number x 10^{-6} per Second)	9,342,609.3	9,342,609.3	9,404,290.3	10,214,367.0	11,012,107.4	8,569,541.4
Pollutants from Sanitary Landfill Leachate						
Total Volume (Liters per Year) 6/	4,095,616	Same as 1.	Same as 1.	Same as 1.	Same as 1.	Same as 1.
Pollutants (Kilograms per Year) 7/						
BOD	44,437.3	Same as 1.	Same as 1.	Same as 1.	Same as 1.	Same as 1.
N	1,789.8					
P	28.7					
FCB (Number x 10^{-6} per Year)	462.8					

Source: Real Estate Research Corporation, op. cit., Task II, p. 150.

3. Noise Pollution

   a. This area is not a primary consideration for environmental problems associated with housing.

   b. A major noise problem occurs at the ground level of high-density areas.

   c. A description of design noise level and land use relationships follows. (See Exhibit D-XII)

4. Solid Waste Generation

The Real Estate Research Corporation computed solid waste volumes at four pounds per capita per day. The following exhibit summarizes their findings.

Exhibit D-XI

	Housing Pattern (1,000 Units)				
	A	B	C	D	E
	Single-Family Conventional	Single-Family Clustered	Townhouse Clustered	Walk-Up Apartment	High-Rise Apartment
Waste Generation, Pounds per Week	98,560	98,560	92,400	92,400	79,100
Compacted Waste, Cubic Yards/Week	207	207	195	195	167

5. Ecological Impact

   a. For almost every type of vegetation and wildlife listed, "sprawl" development results in severe adverse environmental effects.[3]

   b. The least percentage of acreage adversely affected is related to planned community developments. (See Exhibit D-XIII)

Exhibit D-XII
COMMUNITY DEVELOPMENT PATTERNS
NOISE

	Community Development Pattern (10,000 Units)					
	I	II	III	IV	V	VI
Noise Source	Planned Mix	Combination Mix 50 Percent PUD, 50 Percent Sprawl	Sprawl Mix	Low Density Planned	Low Density Sprawl	High Density Planned
Transportation	Open space buffer strips provided along highways in planned communities; dwellings located away from arterial roads; minor roads designed for local access only. Dwellings are insulated from traffic noise, traffic on arterials is less subject to stop-and-go conditions; traffic on local streets is slower and less frequent.	Lack of overall plan does not mean there are no buffers along roadways; however, less efficient traffic pattern than in I is likely. Houses may be exposed to noise along arterial roads. Planning and design of PUD may reduce noise impact.	Noise impacts on residential areas from arterials and highways are more likely to occur than in I or II.	Same as I; although lower density may mean more auto use and increased noise, these noise impacts are spread over a larger area, thus lessening the adverse effect.	Buffers more likely to be lacking than in III. Much greater total automobile travel than in I. Greater diffusion of noise impacts due to lower density.	Same as I. Denser development may cause more concentrated traffic flow which must be compensated for with buffers and setbacks.

Source: Nicholas Quennell, Landscape and Environmental Planning. Derived with reference to Bragdon "Noise Control in Urban Planning" (ref. no. 16-002) and Cohen, "Location Design Control of Transportation Noise" (ref. no. 16-006).

Exhibit D-XIII
COMMUNITY DEVELOPMENT PATTERNS
VEGETATION AND WILDLIFE

	I	II	III	IV	V	VI
Type of Vegetation and Wildlife	Planned Mix	Combination Mix 50 Percent PUD, 50 Percent Sprawl	Sprawl Mix	Low Density Planned	Low Density Sprawl	High Density Planned
Open agricultural land: grasses or cultivated fields; rabbit, quail, pheasant and rodents. Early successional oldfields: pine, cedar, birch, songbirds, rabbit, quail, pheasant, small mammals.	Due to density of development, more agricultural land is likely to be preserved. Large contiguous vacant areas are less subject to adverse effect.	Impact somewhat more severe than in I, as large vacant tracts are broken up.	Assuming that agricultural and oldfield land is developed in preference to woodland, little or no agricultural habitats would be preserved.	Low density development will cause more extensive adverse effects than in I.	No vacant undeveloped land is left, thus eliminating all agricultural habitats.	Impact is least severe due to preservation of large agricultural tracts.
Woodland edge: dense shrub, small tree undergrowth, small mammals, songbirds.	Large unbroken tracts are less subject to adverse effects. Planned development will avoid woodland edges more consciously than sprawl.	Impact somewhat more severe than in I, as large tracts are broken up.	Leaves little undisturbed woodland edge. Small isolated woodlots surrounded by urban development are subject to abuse and lose their value as natural habitats. Their drainage patterns are frequently disturbed by surrounding changes.	Same as I; however, less acreage is left undisturbed.	Same as III.	Same as I; greatest proportion of undisturbed area due to high density and planned development patterns.
Dense woodland with dense undergrowth; small and large mammals, game birds.	Even in planned communities, some of these areas are likely to be cleared and thinned for recreation purposes, eliminating protective cover and food for wildlife species.	Same as I.	All such acreage is likely to be cleared, eliminating protective coverage and food sources for wildlife species.	Greater proportion of area disturbed than in I.	Same as III.	Same as I.
Dense woodland with sparse undergrowth.	Same as for woodland edge.	Same as for woodland edge.	Same as for woodland edge.	Same as for woodland edge.	Same as for woodland edge.	Same as for woodland edge.
Swamps, wetlands, and ponds: wild fowl, freshwater aquatic birds, otter, muskrat, beaver, fish, frogs, turtles.	Carefully protected.	Some intrusion.	Little care taken to protect these areas; if left undeveloped, it is because of economic constraints rather than ecological considerations.	Same as I.	Same as III.	Same as I.
River and creek edges: fish breeding.	Carefully protected.	Some disturbance.	Little care taken to prevent disturbance, which can cause severe sedimentation and attendant water quality problems.	Same as I.	Same as III.	Same as I.
Arid and semi-arid scrub and desert plant associations: ground squirrels, rabbit, kangaroo rat, coyote, snakes and other reptiles.	Even in planned communities, very little will be left in a natural state due to fire and other hazards. In hilly areas, a higher proportion of undisturbed land may be protected. Given the common preference for grassy lawns (which must be irrigated in arid climates), little natural landscape will be preserved.	Same as I.	Same as I.	Same as I.	Same as I.	Same as I.

Source: Nicholas Quennell, Landscape and Environmental Planning.

B. Indirect Impact

1. Transportation

a. Auto Emissions

(1) Stricter pollution control standards being applied to motor vehicles will minimize auto emissions.

(2) Planned-Unit Developments generate less automobile pollution than urban sprawl because of less roadways and often greater concentration of neighborhood facilities.

Exhibit D-XIV

Emissions from PUD's Vehicles in Pounds per Weekday

	Hot-Running Emissions			Cold-Start Emissions		Total Emissions in Pounds
Year	For	gm/mi [1]	emissions in pounds [2]	grams/start [3]	emissions in pounds [4]	
1977	NO_x (as NO_2)	2.54	188.99	2.49	5.56	194.55
	CO	22.16	1,650.30	91.40	204.12	1,854.42
	HC	3.32	247.02	5.18	11.57	258.59
1980	NO_x (as NO_2)	1.52	113.10	0.17	0.38	113.48
	CO	6.55	487.35	54.69	122.14	609.49
	HC	0.93	69.20	3.46	7.73	76.93
1985	NO_x (as NO_2)	0.99	73.66	–1.04 [5]	–2.32	72.62
	CO	0.90	66.96	43.06	96.16	110.02
	HC	0.25	18.60	2.68	5.99	24.59

[1] Source: General Research Corp., "Morning Vehicle-Start Effects on Photochemical Smog," Table 5; and California Air Resources Board, "Air Pollution Control in California," Figure 7.

[2] Equals (gms/mile x 33,750)/453.6, where 453.6 is the number of grams in a pound.

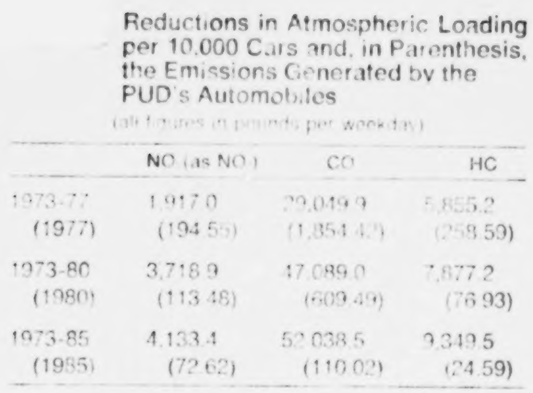
[3] Source: General Research Corporation, *op. cit.*, Tables 3 and 5.

[4] Equals (gms/start x 1,013)/453.6, where 1,013 is the estimated number of vehicles.

[5] 1985 grams/mi as per start are based on test data. "The negative correlation is always used in conjunction with the running emission factor, thereby reducing each post-1975 car's net NO_x contribution to the level predicted for a federal cycle with one cold start, followed by hot-running emissions." See Note E, Table 3, General Research Corp., *op. cit.*

Source: R.L. Crouch and R. E. Weintraub, "Cost-Benefit Analysis of a PUD" Urban Land, June 1973, p. 11.

Exhibit D-XV



Reductions in Atmospheric Loading per 10,000 Cars and, in Parenthesis, the Emissions Generated by the PUD's Automobiles

(all figures in pounds per weekday)

	NO (as NO)	CO	HC
1973-77 (1977)	1,917.0 (194.55)	29,049.9 (1,854.42)	5,855.2 (258.59)
1973-80 (1980)	3,718.9 (113.48)	47,089.0 (609.49)	7,877.2 (76.93)
1973-85 (1985)	4,133.4 (72.62)	52,038.5 (110.02)	9,349.5 (24.59)

Source: Ibid, p. 12.

(3) Gasoline-powered vehicles emit significantly more pollutants in urban areas than in rural areas. (See Exhibit D-XVI)

Exhibit D-XVI

AVERAGE EMISSIONS FROM GASOLINE-POWERED VEHICLES

Pollutant	Average Emission (Grams per Mile)				
	1960	1965	1970	1972	1975
Carbon Monoxide (CO)					
Urban	120	120	95	85	60
Rural	70	70	60	50	35
Hydrocarbons (HC) (Exhaust)					
Urban	16	16	12	9.5	6
Rural	10.5	10.5	8	6.5	4
Hydrocarbons (HC) (Evaporation & Crankase)	6.8	5.4	3.6	2.75	1.0
Nitrogen Oxides (NO_x as NO_2)	6.6	6.6	6.6	6.2	4.9
Particulates	0.3	0.3	0.3	0.3	0.1

Average Speed Adjustment Factors for Automobile Exhaust Emissions

Average Speed (mph)		Carbon Monoxide	Hydrocarbons
Urban	15	1.55	1.4
	25	0.96	0.9
	35	0.72	0.7
Rural	35	1.18	1.17
	45	1.00	1.0
	55	0.85	0.88
	60	0.78	0.82
	65	0.73	0.79

Source: Massachusetts Department of Public Works Draft - Environmental Impact/Section 4(f) Statement, December 1972, p. 1-92.

III. NON LAND USE ENVIRONMENTAL STRATEGIES

A. Management Control Strategies

1. Coordinated large scale development:

   a. Allows for more efficient site planning.

   b. Provides more convenient location to shopping, job, and recreational facilities, compared to unplanned sprawl.

2. Condominium and co-operative ownership provides larger economic and comprehensive base for environmental improvements to residential property.

B. Incentive Zoning

1. Developers who include environmental amenities such as public open space in central cities or direct access to mass transit are allowed certain considerations (e.g., added building height).

2. Some cities have suspended zoning restrictions for the right "to govern the overall balance of buildings, circulation space, and other amenities." (Source: Walter McQuade, "Downtown in Looking Up," Fortune, February 1970.)

C. Improved Public Transportation

See report on Highways and Public Transit.

D. Design Buildings to Conserve Energy

1. Optimal orientation for sun and shade.

2. Use of building materials to capture solar energy.

3. Consider wind tunnels and air flows in planning location and height of buildings.

4. Provide proper ventilation and light.

E. Air Pollution

1. Reduce energy consumption by individual households.
2. Improve auto emission controls.
    a. Limit automobile traffic.
    b. Develop efficient, less polluting mass transit.
3. Control point emission sources.
4. Place local controls on incinerators, furnaces, and leaf burning.

F. Solid Waste Disposal

1. Augment use of trash compactors and home disposal units.
2. See report on Solid Waste.

G. Water Pollution[1]

1. Require erosion control measures during construction and installation of storm drainage systems during the development system to prevent flooding.
2. Trap silt and sediment in temporary catchment basins; protect disturbed slopes by seeding or mulching.
3. Treat pollutants in storm runoff to remove B. O. D. and other harmful substances.
4. Regionwide sewer system planning to prevent poorly treated sewage from one community affecting the water quality of downstream areas.

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[1] Real Estate Research Corporation report.

H. Noise Pollution[1]

1. Reduce noise at the source or create barriers to protect those likely to be disturbed by the noise.

2. Improve insulation of individual dwelling units.

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[1] Real Estate Research Corporation report.

IV. LAND USE LOCATIONAL STRATEGIES

A. Planned Unit Development

1. Larger scale development "for a mix of varying residential densities, shopping and public facilities under a unified plan" (Environmental Plan for New York State, 1973, p. 21). Environmental consequences identified on a more comprehensive scale.

2. Includes all housing types (from single family detached to high rise apartments). Gives town a balanced community and does not contribute to traditional urban sprawl.

3. Cluster Planned

   a. More land freed for open areas (at least 25% open space in planned unit developments) - "PUD is Good for Everybody," House and Home, September 1969, p. 74.

   b. Open space left in its natural state whenever possible and allows buildings to be sited so remaining land can be minimally disturbed (House and Home, op. cit.).

   c. Unified planning allows for less roads, utilities, and services. Thus, less land must be disrupted for installation and maintenance. (See Exhibit D-XVII)

B. Improve Housing in Inner Cities

1. Retardant against urban sprawl.

2. Brings residents closer to jobs and shopping.

3. Revitalizes decaying areas of the city.

C. Site Planning

Basic considerations for optimal use of land:[1]

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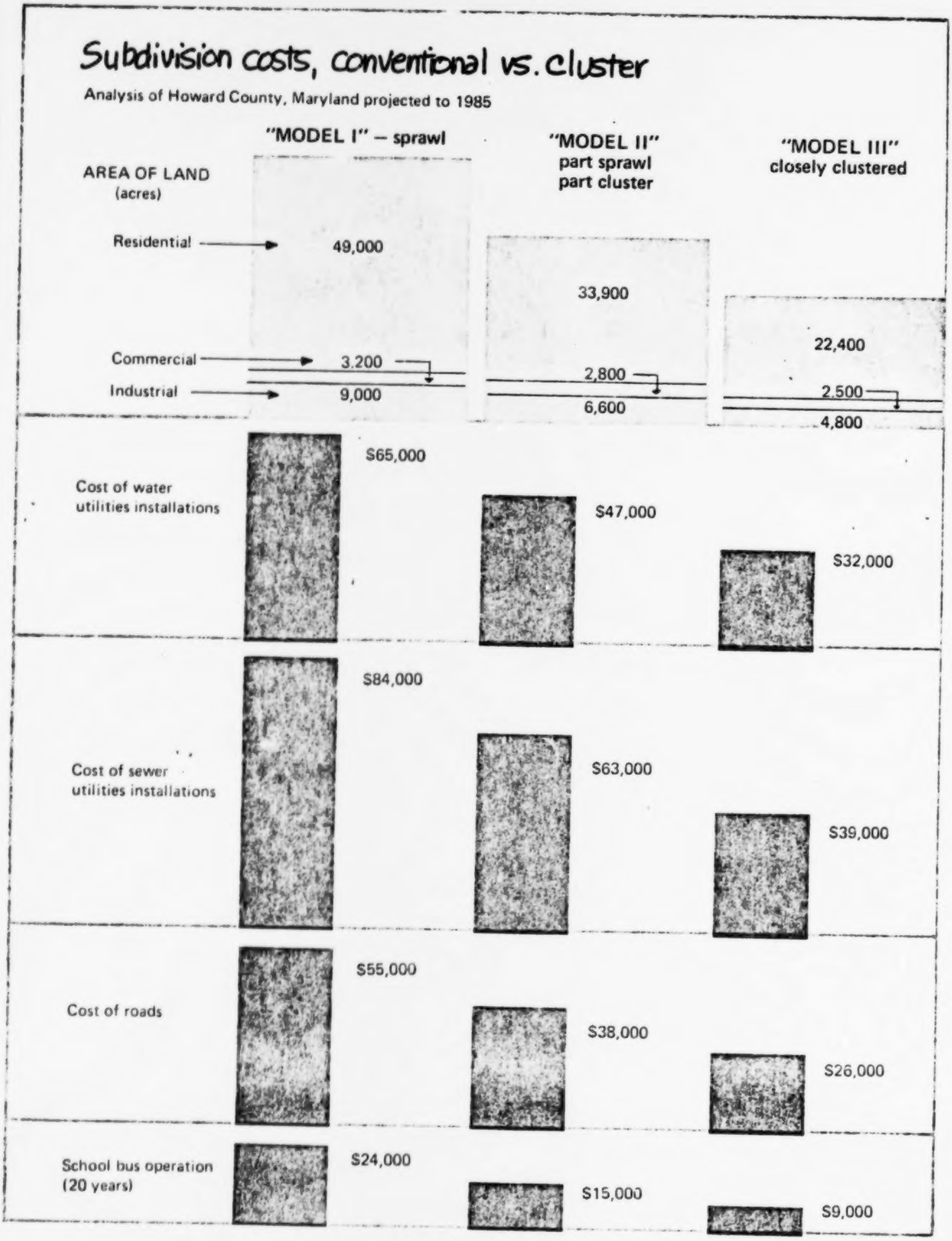
[1] "PUD is Good for Everybody," House and Home, September 1969, p. 76.

Exhibit D-XVII



Subdivision costs, conventional vs. cluster

Analysis of Howard County, Maryland projected to 1985

1. Topography determines:

   a. Basics of building sites, possible areas of erosion.

   b. Environmental effects of varying slope conditions.

   c. How much earth should be moved or remain in its neutral state.

The impact of increasing slope on site development costs and on the environment is summarized below:

Slope Range	Direct Cost Effects	Environmental Effects
0-5%	Least expensive with regard to grading costs. Total site development costs, however, may be more costly for low density structures than on slopes of 5-10%. This is due to problems of gravity flow systems in flat terrain.	Serious drainage problems on slopes less than 1%. Othersie, little adverse effect.
5-10%	Will increase grading costs 70-170% over costs in 0-5% slope. Total site development costs lowest for low buildings; for walk-up and high-rise apartments, 18% to 40% increase over 0-5% slope costs.	Little adverse effect
10-15%	Grading costs may be 5 to 6 times the cost of development on 0-5% slope and 2 to 3 times cost on 5-10% slope. Total site development costs may more than double.	High erosion potential in silty soils without protective measures. Problems in using septic tank sewage disposal due to pollution hazards from leachate.

2. Vegetation functions as a:
    a. Natural cleansing effect from pollution.
    b. Buffer zone between active and passive areas.
    c. Visible natural asset.
    d. Aid to seasonal requirements (shade in summer, sun in winter).
3. Soil and Water Studies
    a. Less roads mean less runoff; water table should be maintained.
    b. Studies indicate feasibility of building lakes, altering wetlands.
4. Microclimate Studies
    a. Influence siting and orientation of buildings.
    b. Consideration of sun, shade, and wind conditions conserves energy.
5. Noise Considerations
    a. Locate residential developments away from serious noise hazards (such as jet airports).
    b. Strategic placement of noise-producing sources (such as play areas or trash collection areas) reduces this pollution impact.

Appendix E
Part 1: AGRICULTURAL LAND USE

I. NEEDS

A. Consumption of agricultural commodities

1. U.S. per capita food consumption (food and kindred products) is expected to remain at the 1972 level of about 1,560 pounds;[1] total U.S. consumption, therefore, will grow in relation to the population growth.

2. Level of livestock production remained stable between 1971 and 1972.

3. Per capita consumption of beef increased by 2 pounds in 1972, reaching 115 pounds; per capita consumption of lamb and mutton continued to decline to a record low of 3 pounds.

4. U.S. Department of Commerce estimated the growth rate of the recent past and projected annual growth (including price rise effects) in the food processing industries.

Exhibit E-I

Selected Food Products: Projections 1971-80

[Value of shipments in millions of dollars except as noted]

SIC	Industry	1971[P]	1972[1]	Percent Increase 1971-72	1973[1]	Percent Increase 1972-73	1980	Percent Increase 1972-80[2]
20	Total food	89, 318	94, 303	6	99, 791	6	145, 155	5.5
2011	Meat packing plants	18, 747	19, 870	6	21, 065	6	31, 590	6.0
2013	Sausage and other prepared meat products	3, 749	3, 975	6	4, 210	6	6, 830	6.0
2015	Poultry and small game dressing and packing, wholesale	3, 493	3, 705	6	3, 925	6	5, 845	6.0
2022	Cheese, natural and processed	2, 565	3, 027	18	3, 602	19	6, 890	11.6
2023	Condensed and evaporated milk	1, 569	1, 820	16	2, 129	17	2, 860	6.9
2024	Ice cream and frozen desserts	1, 171	1, 194	2	1, 224	3	1, 525	3.0
2026	Fluid milk	8, 443	8, 612	2	8, 827	3	11, 015	3.0
2032	Canned specialities[3]	1, 727	1, 830	6	1, 945	6	2, 940	6.1
2033	Canned fruits, vegetables preserves, jams and jellies[3]	3, 932	4, 060	3	4, 190	3	5, 220	3.2
2035	Pickles, sauces and dressings[3]	1, 197	1, 315	10	1, 425	8	2, 365	7.5
2037	Frozen fruit, fruit juices, vegetables, specialities[3]	3, 197	3, 565	12	3, 875	9	6, 780	8.3
2041	Flour and other grain mill products	2, 471	2, 545	3	2, 647	4	3, 515	4.0
2042	Prepared feeds for animals and fowls	5, 727	6, 013	5	6, 374	6	9, 675	6.0
2051	Bread and other bakery products except cookies and crackers	5, 737	5, 909	3	6, 145	4	8, 525	4.5
2052	Cookies and crackers	1, 646	1, 745	6	1, 850	6	2, 900	6.5
2062	Cane sugar refining	1, 641	1, 707	4	1, 784	5	2, 545	5.0
2071	Candy and other confectionery products	2, 002	2, 082	4	2, 186	5	2, 745	3.5
2072	Chocolate and cocoa products	655	717	10	785	10	1, 135	6.3
2092	Soybean oil mills	2, 861	3, 033	6	3, 215	6	4, 835	6.0
2095	Roasted coffee	2, 350	2, 419	3	2, 490	3	3, 050	3.0
2096	Shortening, table oils, margarine and other edible fats and oils n.e.c	2, 021	2, 122	5	2, 228	5	3, 134	5.0
	All other food and kindred products (except beverages)	12, 417	13, 038	5	13, 670	5	19, 236	5.0

[1] Estimated by Bureau of Domestic Commerce.
[2] Compound annual growth rate.
[3] Value of production.
[P] Preliminary.
n.e.c. = not elsewhere classified.

Note: wholesale price index rose by 4% both in 1972 and 1973.

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[1] U.S. Department of Commerce, U.S. Industrial Outlook, 1973, p. 81.

B. Agricultural Population

1. Of the 53 million Americans living in rural areas, those living on farms have gone down to below 10 million, the remainder living in small towns, villages, and on-farm county plots.

2. Many rural areas have lost their residents through outmigration to cities. About one-half of the country's 3,000 counties lost population between 1960 and 1970.

C. Acreage Under Agricultural Uses

1. The 1969 breakdown of the nation's total 2,266 million acres of land in the United States (including Alaska and Hawaii) was as follows:

cropland	430 million acres (more than 20% lay idle for soil improvement)
grassland, pasture and range	645 million acres
forest	725 million acres
urban development, roads and other special uses	186 million acres
desert, swamp, others	280 million acres

2. Rises in crop productivity per unit of land has enabled increased yields on the diminished acreage. Between 1950 and 1967 the number of farms producing food and fiber decreased by 2.5 million and the acreage harvested diminished by a net 34 million. During the same period, food and fiber production in 1967 was 38 percent above that of 1950.

3. In 1972, planted acreage of all crops dropped about 3 percent compared to 1971.

4. In 1969, the acreage under crop growing was 334 million acres, while another 98 million acres of cropland were left idle in soil improvement crops or in pasture.

D. Trends in the Total Agricultural Acreage

Agricultural land is expanding in some areas, while, at the same time, contracting in other areas, as evidenced by the following past or projected trends:

a. Conversion to other land uses:

  (1) 7 million acres of agricultural land will be converted to recreational and wildlife acres by 2000.[1]

  (2) 5 million acres will be consumed by public facilities, second home development and waste control facilities by 2000.[2]

  (3) 730,000 acres of agricultural land are annually being consumed by urban sprawl.

  (4) 300,000 acres of rural land are annually converted to reservoirs and flood control projects.

  (5) In certain rural areas of the East, abandoned crop land has changed to grassland, some of which to be used as pasture while the rest simply abandoned and taken over by the first stage of natural revegetation growth. In some cases the revegetation process has reached a final forest stage via grass and brush stages.

b. New acreage added to agricultural use:

  (1) 4.1 million acres of forested wetlands were cleared and drained for soybean production in the lower Mississippi Valley and Southern Florida between 1950 and 1960.

  (2) Irrigation and drainage is adding new acreage each year. Between 1944 and 1964, private and Government-assisted drainage and irrigation programs brought 22.5 million acres under production. In the past irrigation was mainly applied in the West, while more recently, with the development of new agricultural techniques, irrigation is becoming more widespread.

E. Trends in Rural Land Use in General

The U.S. Department of Agriculture estimates show that 2 million acres of land, excluding surface mining, are converted to non-agricultural use each year. Of this,

a. 1 million acres are converted to extensive types of non-agricultural uses, e.g. wildlife refuges, recreation areas or parks.

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[1] Youth Advisory Task Force/EPA, 1973.

[2] Idem.

b. 1 million acres are placed under new intensive uses, e.g.,

(1) 160,000 acres to highways and airports.

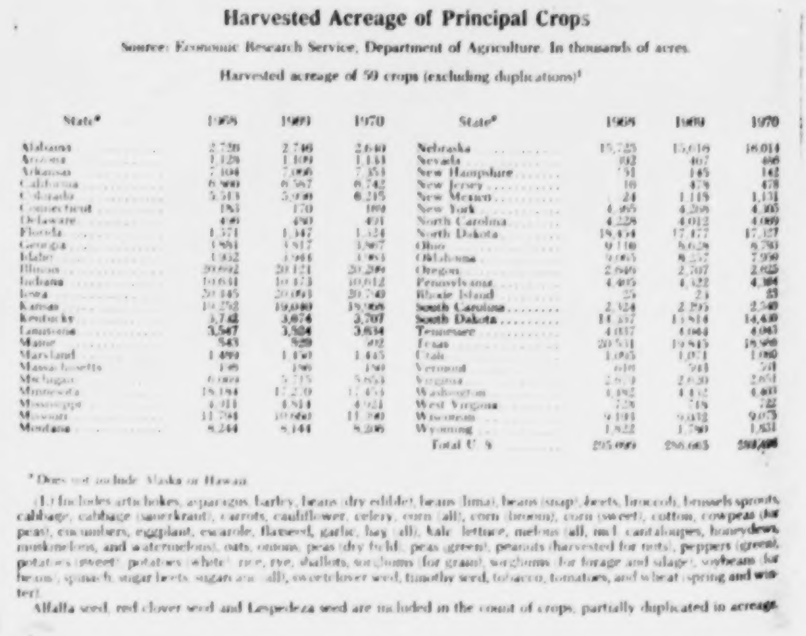
(2) 420,000 acres to reservoirs and flood control projects.

(3) 420,000 acres to urban development. About one-half of the nation's acreage converted to urban uses is taken from cropland and grassland pasture, while the rest comes from forestland and other types of land uses.

F. Geographical Distribution of Agricultural Activities in the U.S.

State-by-state distribution of agricultural activities in the United States (excluding Alaska and Hawaii) is given in Exhibit E-II.

Exhibit E-II



Harvested Acreage of Principal Crops

Source: Economic Research Service, Department of Agriculture. In thousands of acres.

Harvested acreage of 50 crops (excluding duplications)[1]

State[2]	1968	1969	1970	State[2]	1968	1969	1970
Alabama	2,730	2,746	2,640	Nebraska	15,725	15,616	16,014
Arizona	1,129	1,109	1,161	Nevada	412	407	406
Arkansas	7,104	7,096	7,351	New Hampshire	151	145	142
California	6,900	6,567	6,742	New Jersey	[illegible]	479	478
Colorado	5,513	5,930	6,215	New Mexico	1,124	1,119	1,131
Connecticut	183	170	169	New York	4,465	4,266	4,105
Delaware	440	480	471	North Carolina	4,228	4,012	4,069
Florida	1,371	1,347	1,324	North Dakota	19,414	17,477	17,127
Georgia	4,881	4,817	3,867	Ohio	9,110	8,628	8,781
Idaho	1,932	1,966	1,983	Oklahoma	9,065	8,237	7,950
Illinois	20,692	20,121	20,290	Oregon	2,646	2,707	2,625
Indiana	10,631	10,173	10,612	Pennsylvania	4,405	4,322	4,304
Iowa	20,145	20,063	20,740	Rhode Island	25	24	23
Kansas	19,258	19,080	19,808	South Carolina	2,324	2,295	2,340
Kentucky	3,742	3,674	3,707	South Dakota	14,357	13,814	14,430
Louisiana	3,547	3,504	3,634	Tennessee	4,037	4,044	4,063
Maine	543	520	492	Texas	20,531	19,845	19,990
Maryland	1,499	1,450	1,445	Utah	1,065	1,071	1,060
Massachusetts	195	196	190	Vermont	610	588	591
Michigan	6,000	5,715	5,653	Virginia	2,679	2,620	2,651
Minnesota	18,194	17,270	17,451	Washington	4,492	4,412	4,403
Mississippi	4,311	4,814	4,021	West Virginia	726	718	722
Missouri	11,794	10,860	11,390	Wisconsin	9,191	9,032	9,073
Montana	8,244	8,144	8,205	Wyoming	1,822	1,780	1,831
				Total U.S.	295,005	286,663	288,408

[2] Does not include Alaska or Hawaii.

(1) Includes artichokes, asparagus, barley, beans (dry edible), beans (lima), beans (snap), beets, broccoli, brussels sprouts, cabbage, cabbage (sauerkraut), carrots, cauliflower, celery, corn (all), corn (broom), corn (sweet), cotton, cowpeas (for peas), cucumbers, eggplant, escarole, flaxseed, garlic, hay (all), kale, lettuce, melons (all, incl. cantaloupes, honeydews, muskmelons, and watermelons), oats, onions, peas (dry field), peas (green), peanuts (harvested for nuts), peppers (green), potatoes (sweet), potatoes (white), rice, rye, shallots, sorghums (for grain), sorghums (for forage and silage), soybeans (for beans), spinach, sugar beets, sugarcane (all), sweetclover seed, timothy seed, tobacco, tomatoes, and wheat (spring and winter).

Alfalfa seed, red clover seed and Lespedeza seed are included in the count of crops, partially duplicated in acreage.

II. ENVIRONMENTAL IMPACT

A. Direct Impact

1. Water Pollution

a. Soil Erosion by Water

(1) Some 4 billion tons of sediments are washed into U.S. tributary streams each year, and about one-fourth of this is eventually transported to the sea. At least half of this sediment is generated from agricultural land or combined 75 percent from agricultural and forest lands together. Out of the total U.S. cropland of about 300 million acres, water erosion is a dominant problem on 179 million acres and it is a secondary problem on another 50 million acres.[1]

(2) Development of land for agricultural purposes may increase erosion rates by 4 to 9 times the rates from the same land undeveloped.[2]

(3) Effects of soil erosion

(a) Sediment erosion makes agricultural practice on the land less productive. Sediments from agricultural and forest lands together lose 2.6 million metric tons of nitrogen, 1.7 million tons of phosphate, and 32.5 million tons of potassium.

--Increases need for fertilizers
--Increases need to transport chemicals

(b) Sediments can destroy irrigation systems.

(c) Sediments settled in a body of water can destroy the aquatic life at the bottom of the water.

(d) Reduced dissolved oxygen contents and toxic materials adversely affect aquatic life. Silt particles carry many inorganic and organic materials into them. Phosphorus, in particular, is a significant source of eutrophication. Many water-insoluble pesticides (such as chlorinated hydrocarbons) are carried into the water.

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[1] U.S. Department of Agriculture, Wastes in Relation to Agriculture and Forestry, March 1968, p. 6.

[2] Laurent Hodges, Environmental Pollution, Holt, Rinehart, and Winston, Inc., New York, 1973, p. 135.

(e) Interferes with domestic and industrial uses of water and causes extra expenses for clarification of the water.

(f) Adversely affects the recreational values of lakes, reservoirs, and streams.

(g) Shortens the life of farm ponds, reservoirs, and streams.

(h) Alters the size and configuration of a stream in response to increased hydrologic loadings by reestablishing equilibrium flow.

Exhibit E-III

CHANNEL ENLARGEMENT EFFECTS OF LAND USES IN A ONE SQUARE MILE BASIN

Land Use Type	Effect[1]
Land in Cultivation	1.29
Wooded Land	.75
Land in Golf Courses	2.54
Areas of Houses $\geq$ 4 Years Old, Fronting on Sewered Streets	2.19
Area of Sewered Streets $\geq$ 4 Years Old	5.95
Other Impervious Area $\geq$ 4 Years Old	6.79
Non-impervious Developed Land, Plus Impervious Area $\geq$ 4 Years Old and Unsewered Streets and Houses	1.03
Open Land (Residual Category)	.90

[1] Post development channel size ÷ predevelopment size (in terms of cross-sectional area).

Source: Alan M. Voorhees & Assoc., Water Resources Engineers, Inc., and Environments for Tomorrow, Inter-Relationships of Land Use Planning and Control to Water Quality Management Planning, prepared for EPA, April 1973, p. 50, based on Hammer, May 1972.

b. Contamination of Water by Fertilizers

(1) 32 million tons of fertilizers are annually applied,[1] and there have been rapid increases in fertilizer applications over the last two decades. Although difficult to establish, excessive application rates and improperly timed applications are said to prevail in many parts of the country.

(2) Fertilizers are transported into groundwater by leaching and into waterways by natural drainage and storm runoff.

(3) Cause health hazard to humans and animals, particularly from nitrate poisoning.

(4) Plant nutrients in waterways contributed from agricultural sources are of significance, although less important than those generated from natural and municipal sewage.

Exhibit E-IV

Natural and man-generated sources of nitrogen and phosphorus in the United States [14]. Data are in millions of metric tons per year.

	Nitrogen	*Phosphorus*
Natural	**935–3800**	**222–643**
Man-generated	**3610**	**620–920**
Domestic sewage	1200	350–405*
Runoff from urban land	180	17
Runoff from cultivated land	1850	100–345
Runoff from land on which animals are kept	380	153
Total	**4545–7410**	**842–1563**

*** The contribution from detergents is estimated to be 254 million metric tons.**

Source: Hodges, op. cit., p. 134.

(5) Nitrogen and phosphorus cause eutrophication. Phosphates are generally carried into waterways adsorbed to sediment, in a state unavailable for plant growth.

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[1] Youth Advisory Task Force/EPA, 1973.

c. Contamination of Water by Pesticides
(also see the section on the Ecological Balance)

(1) Contamination of water as well as of soil and air results from use of pesticides. Furthermore, as the substance passes through the food chain, it becomes biomagnified by increasing concentrations at each stage of the food chain.

Exhibit E-V

INCREASING CONCENTRATIONS OF CHLORINATED
HYDROCARBONS THROUGH BIOMAGNIFICATION
(LAKE MICHIGAN)

Medium	Residues (in parts per million)
Bottom sediments	0.0085
Small invertebrates	0.41
Fishes	3.0 - 8.0
Herring gulls	3177

Source: CEQ, Integrated Pest Management, November 1972, p. 5.

(2) No organic herbicides are registered for use in potable water, while certain herbicides for aquatic weed control are registered for use in water that is applied to irrigation purposes.

d. Contamination of Water by Animal Wastes
(also see the section on solid wastes)

(1) Some animal wastes get into water supplies when confinement areas are cleaned or when runoff carries the wastes into waterways. About 500,000 metric tons out of 8 million tons of nitrogen produced by farm animals in the U.S. enter waterways annually.

(2) A feedlot carrying 10,000 head of cattle has about the same sewage disposal problem as a city of 164,000 people. Untreated municipal sewage has a BOD content of 100 to 400 ppm, while wastes carried in runoff from barnyards and feedlots may vary in BOD anywhere from 100 to 10,000 depending on dilution and degree of deterioration of wastes.[1]

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[1] U.S. Department of Agriculture, op. cit., pp. 41, 42.

(3) Bacteria-carrying discharge from the 33 duck farms in the Suffolk County, N.Y., caused the closing of the shellfish industry in Moriches and Bellport Bays in 1967.

(4) Feedlot runoff pollutes receiving waters and can cause large fish kills, as in the case of Kansas in 1967. In 1967, feedlot operations were responsible for 16 percent of the fish killed in the United States.[1]

(5) Nitrate contamination of the surface or ground water from feedlots can be a serious health hazard to humans when drinking water becomes contaminated. The effect is particularly serious on babies, resulting in nitrate poisoning (methemoglobinemia or "blue babies.") The U.S. Public Health Service considers drinking water supplies used by infants should not contain more than 10 ppm nitrate, and by adults 45 ppm.[2]

e. Contamination of Water by Rural Domestic Wastes

The use of pit privies, cesspools, or septic tanks may exceed the absorptive capacity of the soil and can result in the contamination of wells, from which drinking water is drawn, and the groundwater.

f. Salinity in Irrigation Water.

Inorganic salts in the soils and geologic materials of arrid regions can find their ways into waterways and be deposited on farms using the irrigated water. The salinity of the soil may build up unless effective drainage is practiced. Out of about 30 million acres of irrigated land in the 17 Western states, salinity is a potential hazard on about one-half of the acreage. Crop production has been affected adversely on about 8 million acres.[3]

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[1] Alan M. Voorhees & Assoc., op. cit., p. 51.

[2] Hodges, op. cit., p. 185.

[3] U.S. Department of Agriculture, op. cit., p. 26.

2. Air Pollution

   a. Airborne Dust (Wind Erosion)

      (1) 30 million tons of natural dust enter the atmosphere in an average year, largely originating from inadequately protected fields under cultivation, deteriorated rangelands and sand dune areas. (Also a small amount comes from highway and industrial construction sites.) Susceptibility to wind erosion is the dominant problem on 55 million acres of cropland in the U.S.[1]

      (2) During the 1930's, duststorms put 6,541,000 acres of land out of cultivation, by destroying crops and removing topsoils.[2] During each of the drought years of 1954 to 1957 on the Southern Great Plains, the annual damages from windblown soil were about as great as during the 1930's.

   b. Burning of Agricultural Refuse

      (1) About 250 million metric tons of agricultural refuse (crop residue, scrub, brush, weeds, grass, etc.) are burned annually in the U.S., largely as a measure of preventing diseases or pests from being transmitted to succeeding crops, but also as a means of residue disposal. Agricultural burning is estimated to contribute to the nation's air pollution problems as follows:[3]

         (a) 8.3 percent of carbon monoxide emissions
         (b) 8.5 percent of particulate matter emissions
         (c) 5.3 percent of hydrocarbon emissions
         (d) 1.5 percent of nitrogen oxide emissions

      (2) Residue burning is more prevalent in the West.[4]

         (a) In one county in California, an estimated 41,000 tons of orchard wastes were burned in 1960.

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[1] U.S. Department of Agriculture, p. 5.

[2] U.S. Department of Agriculture, op.cit., pp. 22-23.

[3] Hodges, op.cit., p. 183.

[4] U.S. Department of Agriculture, op.cit., p. 42.

(b) 30 to 80 percent of 240,000 acres of rice in 8 California counties are burned annually.

(c) 900,000 acres of grass are grown for grass seed each year, producing 2 tons of residue per acre. About one-third of the acreage is burned as a sanitation measure, emitting 50,000 tons of particulate matter.

(3) Residue burning may be the only practical control of plant diseases at present in some cases, e.g., burning of grass seeds residue in western Oregon for the control of blind seed disease.

3. Solid Wastes

These solid wastes generated by agriculture compare to wastes generated from other sources as follows:

Exhibit E-VI

WASTES GENERATED FROM VARIOUS SOURCES

Type of Waste	Total Mass 10^6 metric tons/yr
vegetation[1]	552
animal[1]	1563
household, commercial[2] municipal[2]	226
industrial[2]	100
mineral[2]	1000

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[1] D. Howard, Industrial Location, 1973, p. 434.

[2] Hodges, op. cit., p. 213.

a. Animal Wastes

(1) Animal wastes can be applied as fertilizer. Their nutrient contents are lower than those of artificial fertilizers, and 20 or 30 times as much manure as commerical fertilizer might have to be applied. In addition, the organic matter in livestock manure improves the tilth of the soil and its capacity to hold water, aids in the aeration of the soil, lessens the amount of erosion by wind and water, and has a beneficial effect on soil microorganisms. Most U.S. farmers have preferred commercial fertilizers, however, largely due to their ease of application.

(2) Animal wastes contaminate water, in addition to emitting odor and, sometimes, transmitting diseases.

(3) Domestic animals produce about 1 billion tons of fecal wastes and 400 million tons of liquid wastes. If used bedding, paunch manure from slaughterhouses, and dead animal carcasses are included, the total solid waste production reach 2 billion metric tons a year.[1] Waste production by domestic animals is equivalent to that of human population of 1.9 billion. As much as 50 percent of this waste may be produced in concentrated supply from large feedlot operations.

(4) On a BOD basis, the total farm animal population in the U.S. produces over 4 times as much waste as the human population, while on a total solids basis, the animals produce about 12 times as much.

(5) Animal wastes contain large populations and varieties of bacteria and viruses, some of which may be pathogenic to man or animals and readily waterborne. Estimates of the per capita fecal colifarm indicator microorganism are as follows:[2]

hog	$8,900 \times 10^6$ col/day
cow	$5,400 \times 10^6$ col/day
chicken	240×10^6 col/day

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[1] U.S. Department of Agriculture, *op. cit.*, p. 10.

[2] EPA, *Role of Animal Wastes in Agricultural Land Runoff*, August 1971, p. 9.

(6) The number of large commercial feedlots for confined livestock-feeding and the average number of animals per feedlot (typically 5 to 10 m^2 per animal) have been rising. In 1966 the number of feeder cattle removed for confinement from pastures and grasslands was 10 million, which was an increase of 66 percent in 8 years and 120 percent in 15 years. A feedlot with 30,000 head produces the BOD equivalent of a city of 200,000 people.

(7) Large confinement areas also exist for hogs and poultry. A confinement area for hogs in Hampton, Iowa, occupies 40 acres. Large poultry farms may produce wastes equivalent to those of a fair-sized city. 33 duck farms in the Suffolk County, N.Y., produce wastes equivalent to 130,000 people.

b. Disposal of Dead Animals

For example, the average mortality in hen production is nearly 1 percent monthly, and as a result, some 30 million dead hens must be disposed of annually in the United States. A variety of environmental problems can accompany the disposal of dead animals or birds, depending on the means used:

(1) Produces odor

(2) Incineration is difficult and pollutes the air.

(3) When thrown in old wells, groundwater pollution can occur.

(4) Delivering them to rendering plants may be the best solution.

4. Interference to Ecological Balance

a. Pesticides: Nature of their Applications

(1) Pesticides may be classified by target:

- Insecticides
- Herbicides
- Fungicides
- Rodenticides
- Algaecides
- Molluscides
- Acaricides (Miticides)
- Nematocides
- etc.

(2) Domestic supply (production plus imports minus exports) in 1970 amounted to 658 million pounds, compared with 695 million pounds in 1969 and 228 million pounds in 1950.[1] The significance of this 1970-1971 drop is not certain.

(3) Production and domestic supply of the more persistent chlorinated hydrocarbon insecticides have declined (domestic supply of 244 million pounds in 1956 to 31 million pounds in 1970). During the same time, production of parathions, a group of the organophosphate chemicals used to replace the chlorinated hydrocarbon, increased from 7 million pounds to 57 million pounds.[2]

(4) Two crops, cotton and corn, account for about two-thirds of the total insecticides used. The bulk of the remaining insecticides and most of the fungicides are sprayed on fruit and vegetables. 41 percent of all agricultural herbicides are applied to corn.[3]

(5) There are wide regional variations in the types and prevalence of pests and in pest control practices. A 1966 survey showed that of the 891 million acres under agriculture and pasture lands, only 5 percent received applications of insecticides, 12 percent herbicides, and 0.5 percent fungicides.[4] While cotton accounted for 47 percent of the total agricultural use of insecticides, an estimated 46 percent of the total cotton acreage received no insecticides.

(6) In the U.S. between 5 to 15 percent of total agricultural production is said to be lost annually, with an estimate cost of the damage of 5 billion dollars a year. Application of pesticides has reduced the damage far greater than the cost of pesticides.

(7) Pesticides help eliminate disease-carrying pests, e.g., DDT has reduced incidences of malaria throughout the world.

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[1] CEQ, Environmental Quality, third annual report, August 1972, p. 17.

[2] CEQ, op. cit., p. 17.

[3] Ibid., p. 18, based on 1964 and 1966 surveys.

[4] CEQ, Ibid.

b. Pesticides: Their Effects on Environment and Man

(1) Pesticides contamination from application of excess amounts can affect air, water, soil, or food. The magnitude and nature of these effects are not clearly established.

(2) Emergence of resistant strains of pests:
Exposure of one pesticide sometimes even leads to cross-resistance whereby pests develop resistance not only to the pesticide used but also to other pesticides.

(3) Use of pesticides can adversly affect benefitial non-target species, e.g., bees.

(4) Potential to greatly alter a total ecosystem, basically changing the whole chain of predator-prey relationships and cycles in unanticipated manners.

(5) Effects on humans:
Each year some human deaths occur from pesticides poisoning. A 1969 survey in Iowa conducted by the University of Iowa, reported over 700 cases of pesticide exposures requiring medical attention. Exact extent of long-term effects from pesticides are not well established. However, laboratory tests on mice have shown that the effects could be carcinogenic, mutagenic, or teratogenic (congenital in utero malformations).

(6) Effects on Wildlife:
Pesticides finding their way into food chains can become concentrated (biomagnification) to the level sufficient to damage health and reproductive abilities of animals, birds and fish. Chlorinated hydrocarbons have been identified as the cause of the declines in certain bird populations. The fish kills in the Mississippi and Atchafalaya Rivers in Louisana were eventually traced to the endrin, although not so much from its spraying over cane sugar fields which were surrounded by levees, but originating from a chemical plant producing the endrin. There are a variety of sublethal effects of various pesticides on wildlife, constantly being discovered by

experiments. These possibilities include the effect of chlorinated hydrocarbon pesticides on photosynthesis and growth of marine phytoplankton, and those of DDT on the central nervous system of certain fishes.

(7) Defoliation:

Use of excessively volatile herbicides, which are used to kill certain unwanted trees and sbrubs, can kill or injure vegetation in neighboring areas. The use of 2, 4-D by corn growers and the highway department in Western Iowa caused grape production to drop 96 percent during the 1960's.

B. Indirect Impact

Various types of food-and-fiber-processing plants are located in close proximity to areas of agricultural raw material production due to the perishable or bulky nature of the material. Wastes from these processing operations can be potential sources of pollution.

a. Water pollution potentials of agricultural processing industries are summarized in Exhibit E-VII.

b. Processing operations such as cotton gins and alfalfa mills are sources of agricultural dust.

(1) Cotton ginning:[1]

An average of 300 bales are processed each season in 5,000 gins found in the 14 major cotton producing states. The foreign matter to be discarded ranges from 50 pounds per bale for handpicked cotton (of which there is little now) to more than 2,000 pounds per bale for machine-stripped or machine-scrapped cotton. Gin disposes up to 3,000 pounds of wastes, and the dust consists of soil particles, pollen, fungi, fibers, pesticide residues, and various sizes and types of vegetative matter. Over 50 percent of this trash is burned at the gin. With cotton production at 15 million bales and 1,000 pounds of trash per bale, 3,750,000 tons of residues are burned, producing 375,000 tons of particulates in smoke.

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[1] U.S. Department of Agriculture, op.cit., p. 34.

Exhibit E-VII

Estimated pollution loadings of selected agricultural processing industries [1]

Processing industry	Annual production	5-day BOD			Potential daily population equivalent
		Data in literature [2]	Lb. BOD per 1,000 lb. processed	Potential daily load	
(1)	(2)	(3)	(4)	(5)	(6)
	Million pounds			*1,000 pounds*	*Millions*
CANNERIES:					
Apples	1,218	32 gal. 3,600 p.p.m. BOD per case (24 No. 2½ cans).	13.3	44	0.26
Peaches	2,970	50 gal. 2,000 p.p.m. BOD per case (as above).	20.8	169	1.02
Corn	2,364	19.5 lb. BOD per ton corn processed	9.8	63	.38
Tomatoes	9,790	8.4 lb. BOD per ton tomatoes processed.	4.2	113	.68
Canning (total)				1,370	8
CORN WET MILLING.	10,800	1 bu. = 1-2 PE	4.5	133	.80
COTTON (processed through basic dyeing step).	4,600	*PE* Sizing 2 Desizing 96 Kiering 108 Bleaching 17 Scouring 12 Mercerizing 83 Basic dyeing 90 (per 1,000 lb. goods).	68	857	5.14
DAIRY:					
Fluid mild	59,000	16 [3]	[4] 1.0	162	1.0
Evaporated milk	1,888	10.5 [3]	[4] 2.25	11.6	.07
NFDM	2,176	25.0 [3]	[4] 26.4	157	.945
Cheddar cheese	1,157	24.5 [3]	[4] 24.5	77.6	.465
Cheddar whey (dried)	20 percent of total.	17.0 [3]		9.7	.06
Cheddar whey	50 percent of total.	350 [3]		500	3.0
Cottage cheese	1,424	350 [3]	[4] 26.5	64.5	.38
Cottage cheese whey	7,500	350 [3]	[4] 165	1,000	6.0
HIDES AND LEATHER	1,300	650 gal. 1,500 p.p.m. per 100 lb. hides	81	300	.18
MEAT:					
Slaughtering and packing.	59,400	14 lb. BOD per 1,000 lb. live weight	14.0	2,300	13.7
PAPER AND PULP:					
Wood pulp	66,000	300 lb. BOD per ton of pulp	150.0	27,000	162.0
Paper and paperboard	96,600	68 lb. BOD per ton of paper	34.0	9,000	54
POTATOES:					
Chips	7.1	29.3 lb. BOD per ton raw potatoes	14.6	106	.64
Dehydrated	2.7	71.1 lb. BOD per ton raw potatoes	35.6	93	.58
Flour and starch	3.2	57 lb. BOD per ton raw potatoes	28.5	91	.55
Frozen french fries	5.4	22 lb. BOD per ton raw potatoes	11.0	57	.34
POULTRY	8,200	33 lb. BOD per 1,000 birds	10.0	225	1.3
SOAP AND FATTY ACIDS	770	1.75 lb. BOD per lb. soap made	1,750.0	3,700	
SOYBEAN	27,200	1.7 lb. BOD per 100 bu	.19	14	.085
SUGAR REFINING:					
Cane	48,600	5.31 lb. BOD per ton	Av. 3.0	800	4.8
Beet	47,900	6.64 lb. BOD per ton			
WOOL SCOURING	130	8 gal. 4,000 p.p.m.	267	100	.6

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[1] Hoover, S. R., and Jasewitz, Leonore B. Agricultural Processing Wastes. Presented at Amer. Assoc. Adv. Sci. Symposium, Washington, D.C., Dec. 27, 1966.

[2] PE = Population equivalent.

[3] Pounds BOD/10,000 lb. milk equivalent.

[4] Milk equivalent.

(2) Vertical integration in agricultural operations is a growing trend. For example, integrated "cattle complexes" include:
- raising and production of feeder cattle
- a feed mill
- manufacture of specialty agricultural systems and equipment
- a meat packing plant

III. NON-LAND VARIABLES AFFECTING POLLUTION IMPACT

A. Abatement Methods

1. Animal Wastes

a. As the animal wastes are brought under water quality control attention, manure disposal will come to make up an important production cost.

b. Ordinary municipal sewage treatment methods are generally not suitable for animal wastes. Raw municipal sewage is continuous and typically has the content of 200 mg/l BOD, 400 mg/l COD, and 40 mg/l nitrogen; feedlot runoff contains slugs of waste and typically contains 1000 mg/l BOD, 8000 mg/l COD, and 700 mg/l nitrogen.

c. Use of manure as fertilizer

d. Animal wastes disposal methods:

(1) Aerobic and anaerobic biologically active systems:

(a) Anaerobic digestion system (has proved successful in the laboratory and in the field under some conditions) uses anaerobic lagoons with small surface area but running deep as far as groundwater permits. The lagoon destroys much of the organic matter and can be combined with an aerobic unit to degrade the remaining soluble and particulate matter. Methane gas is produced by anaerobic digestion. This system may not be suited for treatment of wastes with a high nitrogen content (e.g. chicken manure) which may lead to odors from ammonia production, and cold weather may interfere with proper operation.

(b) Aerobic units generally consist of shallow oxidation ponds or lagoons and have anaerobic conditions at the bottom. This method is quite effective, but requires very large surface areas - 8 acres for 1000 head of cattle and 5 acres for 1000 hogs. Installation of mechanical or diffused aeration system can reduce the area requirement.

(2) Land disposal:

Waste disposal from large confinement feedlots can pose a problem for this simple method. A poultry farm with 100,000 hens can produce 11 tons of manure a day, and its application at a rate of 8 tons/acre requires 540 acres annually. In terms of beneficial use of nutrient contents of the land disposed animal wastes as fertilizer, their application cannot take place on a continuous basis, while, for the nutrients to be effective, the manure must be applied to soil while fresh. During the winter spreading of manure over frozen or snow-covered ground would result in heavy water pollution as a thaw begins. During the growing season, crops are on the ground and manure cannot be worked into the soil.

(3) Spray irrigation of croplands or grasslands with diluted manure:

Many feedlots are building detention ponds (sometimes required by law) to catch runoff from rainstorms, and this water may be sprayed on the land. A hog feedlot with 15,000 hogs in Oregon sprays the water from its lagoon on 200 hectares of pasture and grainfields.

(4) Other methods being practiced or under investigation:

- Subsoil injection of diluted water
- Incineration
- Dehydration
- Composting

2. Methods of Erosion Control

Reduction of erosion rates to 10 to 50 percent of the current rate is possible without affecting agricultural productivity.

- Growing of hedges and other windbreaks and sediment entrapments.
- Mulching: living or dead vegetative cover, e.g., crop residues, to cut down the impact of raindrops on surface soil particles as well as help hold excess water.
- "Strip cropping" whereby different crops are grown in alternate strips.
- Avoiding of overgrazing of grassland by livestock.
- Rotation of crops to include meadow in the cropping sequence may reduce average soil loss from fields by as much as 75 percent.
- Graded cropland terraces may reduce erosion on fields up to 75 percent, and in combination with crop rotations, mulching, minimum tillage, etc., can reduce soil loss to practically zero. Terracing, however, interferes with mechanized agriculture.

3. Alternatives to Inorganic Fertilizers

   a. Return to organic fertilizers such as animal wastes, which would also reduce animal wastes-related pollution.

   b. Crop rotation
      - Legume planting adds nitrogent to the soil.

   c. Government control on fertilizer usage
      - Complete elimination of all fertilizer use, however, would increase per capita food costs about 25% as well as require far greater acreage of land for agricultural production.

4. Alternative to Agricultural Burning

   Agricultural burning and the resulting air pollution problems are likely to continue until better methods for controlling plant diseases are available. Plant residues, when used as mulch to cover the soil surface, reduce wind and water erosion as well as help improve crop yields. They are also used as bedding for poultry and livestock and in manufacture of corrugated cartons.

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[1] Hodges, *op.cit.*, p. 186.

5. Alternatives to Pesticides

   a. Autocide:

      For example, periodic releases of sterilized screwworm flies to suppress the fly population in the southwestern U.S.

   b. Chemosterilization

   c. Sex attractants to lure insects to traps

   d. Juvenile hormones to deter maturing of insects

   e. Natural predators and parasites:

      About 520 different species of predators and parasites have been deliberately imported into the U.S., 115 of which have become established and 20 of these provide significant pest controls.

   f. Bacteria and viruses:

      Application of viruses as pest control agents, however, must be preceded by careful examinations as to all the potential short-term and long-term effects associated with such a technique.

   g. Resistant crop varieties

   h. Cultivation practices to reduce spreading of pests:

      - proper sanitation
      - destruction of crop residues
      - deep plowing
      - rotation of crops and animals on the land
      - planting of crops in strips
      - proper timing of planting to escape major pest damage

   i. Quarantine:

      U.S. Department of Agriculture inspectors at ports of entry have intercepted Mediterranean fruit flies as many as 148 times in one year.

j. Integrated central programs, administrated in proper sequence at the proper times to make the best use of natural controls and eliminate application of excessive pesticides.

k. Other considerations pertinent to reducing the adverse effects of pesticides:

   - Research to replace broad-spectrum, persistent pesticides by those that are more selective and and less persistent.
   - Careful management in application and storage of toxic pesticides, e.g., organophosphates.
   - Avoiding over-application and careful timing in application are of utmost significance.

B. Establishment of maximum trade-off points (including the costs of environmental impact) in terms of the quantity of fertilizer and pesticides applications. At present, over-application is prevalent and unabsorbed portions of chemicals in a state unavailable to plant absorption contribute to pollutants generation.

C. Extensive mechanized farming based on monoculture (single crop cultivation) as widely practiced in the U.S. is highly efficient, but at the same time can lead to rapid depletion of certain same soil nutrients and can increase susceptibility of the crop to diseases. These tendencies require greater uses of fertilizers and pesticides.

D. Diet habits - Americans are largely meat eaters. Production of grains and grasses to provide feed for animals which are in turn consumed as human food is essentially an inefficient use of agricultural land. The same acreage put to soybean production for direct human consumption yields over 10 times as much protein as the acreage under corn to be fed to livestock, which is in turn converted to meat protein.

E. Development of hydroponics versus irrigation.

F. Desalinization of water for irrigation.

G. Re-use of waste products, e.g., raising housefly larvae on chicken litter, then feeding the larvae to chickens, using the litter to create larvae; tomato processing in the field using residues as fertilizer.

H. New multi-use of crops, e.g., cotton for food and clothing.

I. Petroleum as a medium for food production.

J. Substitution of meat protein by fish or vegetation proteins.

IV. LAND USE VARIABLES AFFECTING POLLUTION IMPACT

A. Zoning laws or other regulations that can be used to protect agricultural areas from encroachment can help to relieve pressure for more intensive production through the application of pesticides, herbicides, and fertilizers, or from moving into areas of relatively poor quality soil, e.g., lateritic soil, rugged topography areas.

B. Forced land use management techniques to minimize water pollution.

C. Federal agricultural subsidy programs and price control policies affect the acreage placed under cultivation. Land not being used may be in critical areas or require more biocides.

D. Recent trends toward vertical integration are producing geographically concentrated incidence of agriculture-related pollution.

E. Preservation of family farms (abandonment issue).

F. Use of land for recreation vs. agriculture.

G. Taking of agricultural land for watersheds.

H. Productive soils vs. less productive soils:

The 1967 agricultural land use by the quality of soils showed following distributions:
75% class I soils for agriculture
60% class II soils for agriculture
50% class III soils for agriculture

I. Agricultural land use occupies some of the environmentally fragile environment. For example, 4.1 million acres of forested wetlands were cleared and drained for soybean growing in the south between 1950 and 1969.

J. Urban sprawl is rapidly consuming farms in the outskirts. About 20 percent of all U.S. farms are within the fringes of urban areas, and some of the nation's most fertile farmland lies directly in the path of expanding suburbia. California, a major producer of agricultural products loses 375 acres a day to urbanization. If this rate were to remain constant, half the state's productive farmland would be gone within 30 years; if it continues to accelerate as it has in recent years, 80 percent will disappear.[1] Land use planning on a regional basis, real estate and property taxes changes, and rational zoning are called for in order to control or plan conversion of farmland to urban uses.

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[1] A statement by land use experts, as reported in the Wall Street Journal in 1971.

SUMMARY: AGRICULTURAL LAND USE

1. Timing

   Overall agricultural use acreage may not show much change. However, irrigation and drainage projects are creating new agricultural lands at specific areas, and at the same time, conversion of farmland to urban uses, second-home developments, highway construction, and so forth, are occurring rapidly in certain locations.

2. Magnitude (that is, degree to which the environmental control problem is solved by non-land use versus land use variables)

   a. Non-land use variables:

      (1) Complex environmental effects, in terms of both short-term and long-term, resulting from various agricultural practices are not well understood.

      (2) Many issues involve trade-off considerations which are difficult to establish when costs of the environmental impact has to be accounted for. e.g., pesticides and fertilizer applications are necessary inputs to efficient agricultural production.

      (3) Tends to have non-point source types of environmental impact, and also the degree of impact varies depending on the types of soils, subsoil structure, climate, intensity of use, particular practices employed on the farm, and so forth.

      (4) Rigorous adoption of readily available means for the prevention of soil erosion.

   b. Land use variables:

      (1) Growing demand for space from competing land uses is heavily concentrated around urban and suburban fringe areas, e.g., housing, recreation, industry, etc. Nature and pace of conversion of farmland surrounding growing areas can be effectively placed within the context of a comprehensive regional growth plan. Zoning, taxes, and land-use regulations may be used in achieving this.

      (2) Conversion to other uses of farm areas on agriculturally productive soils; creation of agricultural lands on environmentally fragile

areas or on sloping terrains; location of a generator of concentrated pollutants, e.g., feedlots, may be placed within the framework of land use regulations.

3. Irreversibility

a. Environmental impact:

Agricultural practices produce environmental impact which can be of lasting nature, e.g., air, water, and food contamination from pesticides, and resulting biomagnification, entrophication of waters by nutrients carrying runoff, soil and wind erosion of top soils, and disruption of ecological balance by converting from natural habitat.

b. Land use impact:

Readily convertible to other uses.

4. Possible Benefits or Conflicts

a. Although cause-and-effect relationships are difficult to establish, control of any single source of agricultural pollution would have extensive beneficial impact on the environment.

b. Extensive agriculture (through additional acreage by irrigation and drainage) may spread agricultural pollution thinly, but more widely, although it reduces concentrated pollution.

5. Chain Effect

Recent trends toward vertical integration of agriculture-based processing results in creation of concentrated sources of environmental pollution.

6. Rural versus Urban

Outward spread of urban fringes involves conversion of rural areas.

7. Concentration versus Dispersion

a. Extensive type of agriculture (versus intensive agriculture) which accompanies new creation of agricultural lands by irrigation and/or drainage spreads more thinly agricultural pollutions and avoids concentrated and often accelerated pollutant loads, e.g., requirement of greater fertilizer application per acre. The former would be of advantage to the extent the natural absorptive and purifying capacity is not exceeded.

b. Recent trend for some of the agricultural-processing to be located on the site of raw materials production results in concentrated pollution.

8. Non-degradation

Certain practices, e.g., residues burning and cotton gins, if these are to be conducted on newly created agricultural lands, will contribute to the degradation of the air quality.

Appendix E
Part 2: FORESTRY/SILVICULTURE

I. NEED

A. Nationwide

1. Demands for timber supply have increased 70% over the past three decades.

2. By the year 2000, the U. S. Forest Service and Department of Commerce estimate that the U. S. need for forest products will more than double.

3. Principal sources of demand for forest products :

    a. About 50% of the annual U. S. timber harvest goes directly into home building.

        (1) In the decade ending 1978, Congress has called for 26 million new and rehabilitated housing units, with each single family detached unit consuming about 10, 800 feet per unit.

        (2) To achieve this goal will require as much as twice the lumber, plywood and other wood construction materials as we produced prior to 1968.

        (3) In 1972, lumber consumption was estimated at 47. 1 billion board feet, a record high![1]

            (a) softwood production reached 31. 4 billion board feet.

            (b) hardwood production was approximately 6. 6 billion board feet.

        (4) Domestic lumber mills are running at almost full capacity.

        (5) Imports of lumber increased 19% from 1971 to 1972, reaching 9. 1 billion board feet.

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[1] U. S. Department of Commerce, 1972 Industrial Outlook, pp. 23-25.

b. The second largest source of demand for timber supplies is the pulp and paper industry

   (1) Per capita consumption of paper is presently 560-575 lbs/year (compared to 50 lbs/year in 1900) and forecasts of future consumption estimate that by the year 2000, per capita use will have increased to 1,000 lbs. per year.

   (2) In past years, waste paper has supplied about 20% of the industry's fiber needs.

      (a) In recognition of the need to conserve fiber and alleviate the pressing solid waste disposal problems, interest has focused on new ways to increase the waste fiber content of the industry's products.

      (b) A recycling target of 35% by 1985 has been projected by the National Academy of Sciences.

c. A third major source of demand is for exports.

   Lumber exports in 1972 increased by 30% in volume and softwood plywood exports more than doubled.

d. Other major sources of demand:

   (1) Wood furniture - shipments increased 14% from 1971 to 1972 and are projected to increase at an annual rate of 6% over the next five years.

   (2) Pallet production was 15% higher in 1972 than the 138 million units produced a year earlier.

   (3) Railroad ties and utility poles demand is currently (summer 1973) running very high and shortages are being experienced.

   (4) Other uses of wood include industries producing paneling, kitchen cabinets, moldings, and so on.

4. In his 1971 economic message, President Nixon warned that the United States faces a sawtimber deficit of approximately one billion board feet in the 1970's and a deficit of 8.5 billion board feet by 1985 unless greater productivity is achieved through the introduction or improvement of forestry practices.

B. Land Consumption

1. In 1973, about a third of the nation's land area (759 million acres) was estimated to be in forests.

   a. The forest industries own only about 9% of the forest lands, from which are produced one-third of all timber supplies.

   b. Federal and state governments own 19% of the timberlands; these are partially used for commercial purposes under various multi-use programs.

   c. Four million individual Americans own 39% of the forest lands; while timber is sometimes produced from this land, scientific forestry management techniques are seldom practiced.

   d. Another 33% of public and private forest land is either not suitable for commercial trees, or has been set aside for parks.[1]

2. Today in the United States, trees are still growing on 75% of the forest lands that were here 500 years ago when Columbus landed.

3. Conversion of forest lands to other uses has been accelerating in recent years but more intensive silviculture practices have partially offset the impact of this trend in reducing total timber supplies.

   a. Since 1900, approximately 16 million acres of forestland has been withdrawn permanently for parks and wilderness areas -- about as much land as the combined areas of Rhode Island, New Jersey, Massachusetts, Connecticut and Delaware.[2]

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[1] Commerce Today, December 25, 1972, p. 12.

[2] Ibid.

b. Wildfires, aging of forests, insects and disease claim more forest lands each year than industry harvests.

  (1) In 1965, losses from forest diseases amounted to 1.2 billion board feet; equal losses were suffered from forest insects; this would have been enough lumber to build 100,000 five-room frame houses.

  (2) During a typical year, there are about 150,000 forest fires in this country, which ravage 5-7 million acres.[1]

    (a) Lightning causes more than 7,500 forest fires during the average year.

    (b) Lightning fires are exceptionally expensive to control because, unlike man-caused fires, they often occur in inaccessible country.

c. Industry leaders "fear that as much as 25% of Federal commercial forest land may be withdrawn from harvest as the outcome of restraining litigation begun by preservationist organizations."[2]

d. The commercial forest area is almost equally divided between softwoods and hardwoods, but almost three-quarters of the timber cut consists of softwoods; in general, hardwoods are underutilized, for growth exceeds cut, but in respect to the more valuable species, the situation is much less favorable.

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[1] Much of this acreage is brush and not prime timber.

[2] U.S. Department of Commerce, 1973 Industrial Outlook, p. 26.

C. Regional Concentration

1. Timber production in the United States has shown marked shifts in location in the past, and further changes are inevitable in the future.

    a. The effect of these changes has been substantially to raise the costs of lumber, as the principal centers of production have moved further and further from the main markets which lie in the Northeast.

    b. The diminishing stands of quality virgin timber have also resulted in substantially higher prices for large-diameter logs.

2. The West (i.e., the Pacific and Mountain States, to which the U.S. Forest Service also attaches the Black Hills of South Dakota) has only a quarter of the total forest area, but it produces about half the sawnwood and possesses no less than 70% of the standing timber volume.[1]

    a. The West contains the last remaining stands of virgin forests, some of which, such as the Douglas fir forests and the redwood forests, produce a tremendous volume of timber from one mature stem.

    b. With the felling of these mature forests, the main center of timber production must return to the East, where all forests are second growth.

        (1) In the West, cutting of old growth timber is reducing timber stands faster than they are growing.

        (2) Timber in the South and East, in contrast, is growing faster than it is being cut.

    c. Much of the western forest area has been retained in public ownership; national forests account for 52% of the commercial forest area of the West, but for only 17% of the national commercial forest area.

    d. Washington and Oregon constitute by far the most important lumbering area in the West; these two states alone account for about a third of the national sawnwood production.

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[1] D. W. Fryer, World Economic Development (N.Y., McGraw-Hill, 1965), p. 229.

3. The yellow pine forests of the South produce about 40% of the total output of sawnwood and about one-half of the national pulpwood production.

    a. Industry holdings constitute only 20% of the South's commercial land, but account for more than half of the country's privately owned forest properties exceeding 50,000 acres.

    b. The dominant position of the large private forest property in the South is the result of the great growth of the pulp and paper industry since the 1920's and the economies of scale.

    c. National Forest lands for commercial logging comprise only 10% of these southern timberlands.

    d. 70% of the forests is owned by over one million non-industrial, private individuals, mostly in small tree tracts.

        (1) A "Third Forest Program" sponsored by public and private interests has been initiated to give small owners the incentives and help they need to practice wise forest management.

        (2) The American Forest Institute estimates than an increase of only 1% in the number of tree farms in the South could produce enough additional wood to construct 3,000 new homes per year.

        (3) The goal of the "Third Forest Program" is to double timber growth in the South.

4. Although no longer of importance in sawnwood production save in isolated areas serving mainly local markets, the East and the North are of considerable significance in pulp production, accounting for about 40% of the national output.

    a. A very large proportion of the forest land consists of small lots.

    b. The application of modern forestry methods had been rendered difficult and expensive due to the great dissemination of ownership in this region.[1]

    c. Nevertheless, there is more forest land under second growth in New England now than there was 75 years ago, and second growth can often yield more than primary.

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[1] The problems of adapting modern forestry practices over diversified holdings can be very significant as shown by the Appalachian Commission's efforts in this area.

II. ENVIRONMENTAL IMPACT

A. Direct Impact

1. Water Pollution

a. In terms of water pollution silviculture sources are largely non-point and therefore, difficult to control.

b. The U. S. Department of Agriculture estimates that more than 40 million acres of forest and related rangelands are eroding because of distrubances or destruction of cover.[1]

(1) This acreage produces an estimated 100 million tons of sediment each year (compared to approximately 4 billion tons from agriculture).

(2) Approximately 90% of this sediment is produced by roads, logging skid trails and burned areas, with the major portion resulting from road construction.

(a) These areas are sources of sediment-laden floods and mudrock flows and nutrient and thermal loads that impair water quality.

(b) When the surface mulch of the forest floor is burned, rate of infiltration of rainfall and absorptive capacity of the soil is greatly impaired.

(c) Logging debris left in the forest can clog streams leading to flooding or channel erosion.

(d) Excess runoff from areas of clear cutting can also be a problem if proper management is not applied; each year approximately one million acres of forests are clear cut.

c. Insecticides and herbicides in runoff from forest lands can result in fish kills, and destruction or injury to birds and other types of wildlife.

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[1] U. S. Department of Agriculture, Wastes in Relation to Agriculture and Forestry (Publication No. 1065, 1968), p. 95.

(1) There is a fairly substantial controversy concerning whether monoculture tree farms are more susceptible to disease and lead to greater use of pesticides which are moved into water supplies by runoff.

(2) The use of pesticides has been increasing along with greater intensity of production.

d. Fertilizer, especially from replanting of clear-cut areas result in nutrient runoff and eutrophication.

e. Logging and clear cutting by removing cover can affect the thermal properties of receiving waters; the amount of oxygen that water can hold in solution diminishing with increasing temperature.[1]

(1) One study has found that before clear cutting, the daily maximum temperature variation was 8°F; one year after cutting the value of 8°F was exceeded 82% of the time.[2]

(2) There is some tradeoff, however, in that the debris from clear cutting can be used as compost.

2. Air Pollution

a. Exhibit E-VIII shows the average annual emissions attributed to forest fires; although the percentages show this to be a relatively minor source nationwide, at a local level the impact can be very significant due to the release of tremendous quantities of smoke and hydrocarbons (e.g., smoke from Rocky Mountain forest fires have been found to curtail airport operations as far east as New York and Boston).

Exhibit E-VIII
Nationwide Emission Estimates
from Forest Fires 1970

	10^6 tons/year	% of total
SO_x	Neg.	--
Particulates	1.4	5.3
CO	4.0	2.7
HC	0.3	0.9
NO_x	0.2	0.9

Source: EPA Nationwide Air Pollutant Emission Trends 1940-1970 (Jan. 1973)

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[1] Clear cutting is now prohibited in National Forests.

[2] EPA Studies on Effects of Watershed Practices on Streams (Research Series No. 13010, 1971).

b. Airborne soil particles from soil blowing across clear cut areas can remove top soil and coat leaves, impairing photosynthesis and gas exchange.

c. Air pollutants are emitted from burning of slash.

d. Spray drift of herbicides can injure shade trees and shrubs as much as 10 miles downward from the target area; pesticides can be spread in a similar manner.

3. Noise Pollution

Noise from large machinery,logging trucks and other equipment used by the timber industry can have adverse impact on nesting of wildlife and recreation use.

4. Solid Waste

-- approximately 25 million tons of logging debris are left in the forests each year.

a. This is a reservoir for tree diseases and insects.

b. It is also an extremely serious fire hazard; the average size of forest fires originating in logging waste is more than 7 times that of fires originating in uncut areas.

5. Ecological Imbalance

a. Logging can destroy spawning gravel, killing fish eggs.

b. Clear cutting can destroy a variety of wildlife habitats.

c. Pesticides and herbicides can cause injury to more than the target species.

(1) Disruptions in the food chain can result.

(2) Killing termites can reduce nitrogen-fixation in the soil.

B. Indirect Impact

1. Location of sawmills and pulp and paper mills in forest areas can represent sources of potential air and water pollution.

2. Multi-use of forests and silviculture areas for recreation can lead to adverse environmental impact.

    a. Noise pollution from snowmobiles, trail bikes, ATV's.

    b. Air pollution from auto traffic into recreation areas and from campfires.

    c. Water pollution from improperly treated sewage and leachate from improper solid waste disposal at campsites and second homes.

    d. Soil erosion from off-road vehicle trails or impacted soil at concentrated camping use areas.

III. NON LAND USE FACTORS IN REDUCING ADVERSE ENVIRONMENTAL IMPACT

A. Water Pollution

1. During timber harvesting operations, practices such as patch cutting, reforestation, sediment retention devices, and the protection of natural buffer strips along stream corridors and waterways can minimize exposure of bare soil and the increase in erosion.

2. The abatement of wild fires has made a major contribution in diminishing sediment delivery from forested lands; new developments contributing to this effort include:

    a. Fire danger prediction systems.

    b. Aerial fire control methods.

    c. Low cost fire retardant chemicals.

    d. Infrared fire detection and mapping techniques.

3. Preparing the ground after harvest including removal of slash and debris.

4. Controlled use of fertilizers.

B. Air Pollution

1. Research is underway to develop ways of disposing of logging debris as an alternative to controlled burning; the prospects of discovering an economically feasible method is not bright, since burning costs only $1/ton; chipping cost $12 a ton.

2. Cloud seeding techniques offer a strong potential for reducing or eliminating lightning-caused fires; in field studies heavy overseeding with silver iodide has been found to give a one-third reduction in cloud-to-ground lightning.[1]

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[1] U.S. Department of Agriculture, Wastes From Agriculture and Forestry, 1968, p. 2.

3. Addition of flourescent particles to aerial sprays of forest insecticides.

C. Ecological Balance

1. Development of insecticides with a higher degree of degradability and with minimum toxic effects to humans, farm animals, wildlife, and beneficial insects (e.g., use of less persistent organic phosphorus and the carbonate insecticides in place of the chlorinated hydrocarbon insecticides).

2. Use of lures or bait insecticide combination to control pests with the use of only a few grains of insecticide per acre.

3. Sterilization and genetic methods of control.

4. Development of trees resistant to insects.

5. Logging on a selective basis -- sanitary salvage --to prevent pests from getting a foothold in a stand.

6. Aerial surveillance to watch for tree diseases.

7. Instead of relying solely on pesticides, herbicides, and fertilizers to increase intensity of silvaculture production, give increased importance to:

   a. Growing superior seedlings in tree nurseries before transplanting.

   b. Selective thinning of trees to provide space for more rapidly growing ones.

   c. Expanded use by the pulp and paper industry of small diameter trees and species (weak trees) which were once considered unusable (e.g., investigations into the densely growing puckerbrush that grows over about 25 million acres in the United States).[1]

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[1] "Farming the Forest For Fiber," Environmental Science and Technology, October 1972, p.877.

IV. LAND USE FACTORS

A. Demand for products from our forest resources are at an all-time high and show no signs of diminishing; this factor alone will put increasing pressure on intensifying growth on commercial tree farms as well as encouraging millions of small private owners to consider selling their supplies.

B. Under scientific management great strides have been taken in controlling the sources of air pollution from fires and aerial spraying; some advances have also been made in transporting logs and in clearing debris to reduce excess runoff, erosion and sedimentation, but much remains to be done in the control of adverse impact on water quality.

C. In controlling the adverse impact on water, land use can play an important role.

1. Tree protection laws or acquisition may be used to prevent clearing up to the edges of streams.

2. Siting controls may have applicability in controlling the creation of logging roads and the placement of new lumber or pulp and paper mills.

3. Almost all water pollution problems can be controlled through the application of appropriate land management techniques applied to cutting and clearing, road building, log removal, and the use of biocides and fertilizers. A shift in location, however, may alter the management practices used.

D. The multi-use of forest lands needs further examination to determine whether the combined impact may have a synergistic adverse impact.

E. Trends such as utilizing weed trees or shrubs should be investigated in terms of its implications for overall land use change and corresponding environmental impact.

F. Adoption of criteria for location and construction of logging roads and skid trails can minimize soil disturbance and sediment delivery from timber harvest operations.

SUMMARY

1. Timing

   a. Demand for forest resources is so great as to make it an issue of immediate concern.

   b. Demand for forest lands for a variety of uses (second homes, recreation facilities, airports, and highways, watersheds, wildlife refuges) has also been increasing at a very rapid rate.

2. Magnitude (that is, degree to which the adverse environmental impact associated with silviculture can be controlled by non land use vs. land use variables)

   a. The impact of silviculture on water and air quality is non-point and therefore difficult to control.

   b. Some of the very large tree farms have made strong efforts to reduce adverse environmental impact; however, the desire for more intensive growth can sometimes lead to increased impact; in addition, large quantities of forest lands are under diverse, private ownership where no control effort is made.

   c. Land use can help to correct some of the problems that have not been resolved through the application of technology or scientific management.

3. Irreversibility

   a. The use of persistent pesticides can create injury--sometimes irreparable--to birds, animals, fish, and beneficial insects as far as 50 years or more into the future.

   b. Destruction of watersheds can result from clearing of large areas or from forest fires.

4. Possible Conflicts

   a. More intensive silviculture to meet increasing demand can result in greater adverse environmental impact.

   b. Conflicts due to multi-use

      (1) Noise from logging machinery, the aesthetic impact of clear cutting and so forth may adversely affect recreational use of forest lands.

(2) Trampling of seedlings by recreational visitors and increased fire hazard from camp fires may adversely affect silviculture activities.

5. Chain Effect

Simultaneous increase in the amount of multi-use activity on forest lands can have an environmental impact greater than the sum of the impact of each activity viewed separately.

6. Rural vs. Urban

Increased demand for lumber and pulp and paper products from urbanization can create pressures on forest land irrespective of any changes in population distribution.

7. Concentration vs. Dispersion

A dispersed population pattern may limit the quantity of large tracts of forest lands that offer the greatest economies of scale in production and are the most appropriate to scientific management.

8. Non-degradation

Burning of debris and slash, emissions from mills and logging equipment, and the release of airborne dust and pesticides may degrade the quality of the air in relatively clear air areas.

Appendix F

Part 1: FUEL MINERALS LAND USE

I. NEEDS

A. Coal

1. Demand

a. U.S. Department of the Interior projects that the demand for coal in the United States, including exports, is expected to be as follows (all figures in millions of short tons):

Exhibit F-I
Demand for Coal

Year	Domestic Demand	Export Demand	Total Demand
1971	511	58	569
1975	565	71	636
1980	665	75	740
1985	893	87	980
2000	1,310	108	1,418

Source: U.S. Department of the Interior, U.S. Energy Through the Year 2000. December 1972, p. 33.

b. Despite some potential problems in obtaining capital for new projects, coal resources in the United States appear more than adequate to meet the forecast demand.

c. Coal Consumption by Major Markets-Projections

Exhibit F-II
The Demand for United States Coal Resources
By Major Consuming Sectors
1971 Actual, With Projections to the year 2000[1]

Coal Supply	1971	1975	1980	1985	2000
Domestic Demand:[2]					
Household and Commercial					
Thousands of short tons	14,800	12,000	11,000	4,000	.....
Trillions of Btu	390	325	300	100	.....
Percent of total	2.8	2.1	1.6	.4	.....
Industrial[3]					
Thousands of short tons	164,800	159,000	175,000	190,000	247,000
Trillions of Btu	4,472	4,600	4,750	5,150	6,700
Percent of total	31.5	29.2	26.1	21.6	19.5
Electrical Generation					
Thousands of short tons	331,800	394,000	460,000	613,000	755,000
Trillions of Btu	7,698	8,900	10,660	14,220	17,520
Percent of total	54.4	56.4	58.6	59.6	51.0
Synthetic Gas					
Thousands of short tons	.....	.....	19,000	86,000	308,000
Trillions of Btu	.....	.....	430	2,000	7,140
Percent of total	.....	.....	2.4	8.4	20.8
Total Domestic Demand					
Thousands of short tons	510,800	565,000	665,000	893,000	1,310,000
Trillions of Btu	12,580	13,825	16,140	21,470	31,360
Percent of total	88.7	87.7	88.7	90.0	91.3
Export Demand:					
Thousands of short tons	58,050	71,000	75,000	87,000	108,000
Trillions of Btu	1,587	1,950	2,060	2,390	2,970
Percent of total	11.3	12.3	11.3	10.0	8.7
Total Demand:					
Thousands of short tons	568,850	636,000	740,000	980,000	1,418,000
Trillions of Btu	14,167	15,775	18,200	23,860	34,330

[1] Includes bituminous, lignite, and anthracite coal.

[2] Transportation use negligible in 1971, and included in Industrial Sector. No transportation use forecasted for following time periods.

[3] Includes minor quantities for synthetic liquids.

d. Electric utilities is the largest user of coal comprising over half of the total coal market and will continue to be the major market in the future.

2. Supply

a. Coal Production - 1970

Exhibit F-III

	Million Tons/Year
Bituminous Surface 40.5% Underground 59.1%	590
Subbituminous and Lignite	13
Anthracite	9.5
	612.5

b. The Coal Supply Forecast

(1) Coal resources in the United States appear more than adequate to meet the forecast demand. Some problems are expected in securing the capital necessary to open the requisite mines, in making high sulfur coal environmentally acceptable, and in reclamation of strip-mining areas.

(2) Reclamation of strip-mining areas is both technically and economically feasible, and studies indicate the cost will lie in the \$20 to \$30 per ton range. This means that strip-mined coal can remain competitive with other energy sources. However, if a ban is placed on strip-mining then much of the coal consumption shown will not occur, and it will be replaced by higher priced petroleum products.[1]

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[1] U.S. Department of Interior, op.cit., p.33.

B. Oil

1. Demand

a. Domestic demand for petroleum, according to the Department of the Interior, is expected to continue its dramatic increase:

Exhibit F-IV
Petroleum Demand

Year	Million Barrels	Million Barrels/day
1971	5,523	15.1
1975	6,340	17.4
1980	7,615	20.9
1985	9,140	25.0
2000	12,985	35.6

Source: U.S. Department of the Interior, op. cit., p. 17.

b. Domestic petroleum consuming sectors will distribute themselves accordingly over time:

Exhibit F-V
Domestic Petroleum Consumption

	Million Barrels				
Sector	1971	1975	1980	1985	2000
Household/ Commercial	1,149.6	1,221	1,356	1,546	1,953
Industrial	982.0	1,186	1,383	1,663	2,670
Transportation	3,004.9	3,360	3,992	4,739	7,450
Electrical/ Generation	386.9	573	800	1,064	807
Synthetic Gas	----	----	84	128	105
TOTAL	5,523.4	6,340	7,615	9,140	12,985

Source: U.S. Department of the Interior, op. cit., p. 17.

c. Transportation will remain the largest consumer of processed crude oil over time; industrial demand for petroleum will also rise significantly, while the household and commercial sector will require a smaller proportional increase between 1971 and 2000.

2. Supply

a. In 1971 domestic supply accounted for 74.0% of domestic consumption and imports accounted for 26.0%.

b. Recent energy shortages and political problems with imported oil is leading to increased emphasis on increasing domestic supplies.

(1) Between now and 1980, increases will be in the form of incremental production from conventional domestic sources, both onshore and offshore.

(2) Beyond 1980, supplemental supplies will also be drawn from non-conventional sources such as shale oil, tar sands and coal liquification.

Exhibit F-VI
Estimated Petroleum Supply Schedule
1971 Actual With Projections to the Year 2000

	1971	1975	1980	1985	2000
Total Supply:					
Million Barrels	5,523	6,340	7,615	9,140	12,985
Million Barrels/Day	15.1	17.4	20.8	25.0	35.5
Trillion Btu	30,492	35,090	42,190	50,700	71,380
Domestic Supply:					
Lower 48 Supply[1]					
Million barrels	4,117	4,000	3,740	3,345	2,200
Million Barrels per day	11.3	11.0	10.2	9.2	6.0
Trillion Btu	22,569	22,130	20,720	18,550	12,090
Alaskan North Slope					
Million Barrels	-----	-----	550	730	1,295
Million Barrels per day	-----	-----	1.5	2.0	3.5
Trillion Btu	-----	-----	3,050	4,050	7,120
Synthetic Liquids					
Million Barrels	-----	-----	-----	180	365
Million Barrels per day	-----	-----	-----	0.5	1.0
Trillion Btu	-----	-----	-----	1,000	2,010
Total Domestic Supply					
Million Barrels	4,117	4,000	4,290	4,255	3,860
Million Barrels per day	11.3	11.0	11.7	11.7	10.5
Trillion Btu	22,569	22,130	23,770	23,600	21,220
Supplemental Supplies[2]					
Million Barrels	[3] 1,406	[3] 2,340	[3] 3,325	4,885	9,125
Million Barrels per day	3.9	6.4	9.1	13.3	25.0
Trillion Btu	7,923	12,960	18,420	27,100	50,160
Percent of Total Supply	26.0	36.9	43.7	53.4	70.3

[1] Includes crude oil and natural gas liquids.
[2] May be from imports, shale oil, coal liquefaction, etc. See text for discussion.
[3] All imports.

C. Natural Gas

1. Demand

a. Projected consumption of natural gas, while increasing, will not experience the same dramatic growth as that for petroleum:

Exhibit F-VII
Natural Gas Demand

Year	Million Cubic Feet
1971	22,050
1975	24,462
1980	26,169
1985	27,537
2000	32,959

Source: U.S. Department of the Interior, op. cit., p. 17.

b. The market distribution of natural gas consumers will be as follows:

Exhibit F-VIII
Natural Gas Consumption

	Billion Cubic Feet				
Sector	1971	1975	1980	1985	2000
Household/ Commercial	7,125	8,400	9,195	9,758	10,475
Industrial	10,125	11,387	12,124	12,842	17,401
Transportation	800	989	1,358	1,591	2,522
Electrical/ Generation	4,000	3,686	3,492	3,346	2,561
TOTAL	22,050	24,462	26,169	27,537	32,959

Source: U.S. Department of the Interior, op. cit., p. 17

c. All sectors will increase their demand for natural gas with the exception of electrical generation whose gas requirements will decline steadily over the next three decades.

2. Supply

   a. In 1971 domestic supply accounted for 96% of total consumption with imports accounting for 4%.

   b. DOI projections for 1975 to 2000 assume:

      (1) Increased percentage contribution by imports, especially from Canada.

      (2) Growing domestic gas supplies especially after 1985 from production of Alaskan and Artic Isles reserves.

      (3) Increasing prices making supplemental supplies of LNG and synthetic gas economically feasible in some locations.

Exhibit F-IX
Estimated Gaseous Fuel Supply Schedule,
1971 Actual With Projections to the year 2000

Gaseous Fuel supply	1971	1975	1980	1985	2000
Total Supply:					
Billion cubic feet	22,050	24,462	26.869	29,537	38,459
Trillion Btu	22,734	25,220	27,680	30,390	39,480
Domestic Supply:					
Domestic Natural Gas[1]					
Billion cubic feet	21,150	21,962	22,269	21,837	22,159
Trillion Btu[2]	21,810	22,640	22,960	22,510	22,850
Synthetic Gas					
Billion cubic feet	.....	.....	700	2,000	5,500
Trillion Btu[3]	.....	.....	700	2,000	5,500
Total Domestic Supply					
Billion cubic feet	21,150	21,962	22,969	23,837	27,659
Trillion Btu	21,810	22,640	23,660	24,510	28,350

[1] includes Alaska

Source: U.S. Department of the Interior, op. cit., p. 32.

c. Production of the synthetic gas from coal is dependent on making the mining of coal (principally strip mining) environmentally acceptable. The alternative to not producing this synthetic gas from coal is heavier dependence on petroleum and petroleum products.

D. Fossil Fuel Minerals - Summary

1. U.S. Total Gross Consumption in Standard Physical Units by Major Sources and Consuming Sectors:

Exhibit F-X

Year	Consuming Sector	Coal[1] million short tons	Petroleum[3] million barrels	Natural Gas billion cubic feet	Nuclear power million kilowatt-hours	Hydropower million kilowatt-hours	Synthetic gas distributed million cubic feet	Utility electricity distributed million kilowatt hours
1971	Household and Commercial .	14.6	1,149.6	7,125.0			-	926,100
	Industrial	164.3	982.0	10,125.0			-	682,560
	Transportation.	0.3	3,004.9	800.0			-	5,340
	Electrical Generation	331.6	386.9	4,000.0	37,899	268,320	-	(1,814,000)
	Synthetic Gas	-	-	-	-	-	-	
	Total	510.8	5,523.4	22,050.0	37,899	266,320		
1975	Household and Commercial .	12	1,221	8,400.0			-	1,242,000
	Industrial	169	1,186	11,387.0			-	882,000
	Transportation.	-	3,360	989.3			-	6,000
	Electrical Generation.	384	573	3,685.7	240,150	350,000	-	(2,130,000)
	Synthetic gas	-	-	-	-	-	-	
	Total	565	6,340	24,462.0	240,150	350,000		
1980	Household and Commercial .	11	1,356	9,195			320	1,770,000
	Industrial	175	1,383	12,124			380	1,221,000
	Transportation.	-	3,992	1,358			-	9,000
	Electrical Generation.	460	800	3,492	630,300	420,000	-	(3,000,000)
	Synthetic gas	19	84	-			(700)	
	Total	665	7,615	26,169	630,300	420,000		
1985	Household and Commercial .	4	1,546	9,758			940	2,286,000
	Industrial	190	1,663	12,842			1,060	1,843,000
	Transportation		4,739	1,591				11,000
	Electrical Generation	613	1,064	3,346	1,130,000	469,600	-	(4,140,000)
	Synthetic Gas	86	128	-	-	-	(2,000)	
	Total	893	9,140	27,537	1,130,000	469,600		
2000	Household and Commercial .	-	1,953	10,475	-	-	2,640	4,417,000
	Industrial	247	2,670	17,401	-	-	2,860	4,578,000
	Transportation	-	7,450	2,522	-	-	-	15,000
	Electrical Generation	755	807	2,561	5,470,000	700,000	-	(9,010,000)
	Synthetic Gas	308	105	-	-	-	(5,500)	-
	Total	1,310	12,985	32,959	5,470,000	700,000		

[1] Includes anthracite, bituminous, and lignite coals.

[3] Petroleum products refined and processed from crude oil, including still gas, liquefied refinery gas, and natural gas liquids.

Source: U.S. Department of the Interior, op. cit., p. 17.

2. U.S. Total Gross Consumption in Trillions of Btu's by Major Sources and Consuming Sectors:

Exhibit F-XI

	Coal[1]	Petroleum[2]	Natural gas	Total fossil fuels	Nuclear power	Hydro power	Total gross energy inputs	Synthetic gas distributed	Total four sector inputs	Utility elec. distributed	Total three sector inputs
1971 Household & Commercial	390	6,545	7,346	14,281	-	-	14,281	-	14,281	3,160	17,441
Industrial	4,465	5,391	10,438	20,294	-	-	20,294	-	20,294	2,329	22,623
Transportation	7	16,139	825	16,971	-	-	16,971	-	16,971	18	16,989
Electrical Generation	7,698	2,417	4,125	14,240	405	2,798	17,443	-	17,443	(5,507)	-
Synthetic Gas	-	-	-	-	-	-	-	-	-	-	-
Total	12,560	30,492	22,734	65,786	405	2,798	68,989				
1975 Household & Commercial	325	6,950	8,660	15,935	-	-	15,935	-	15,935	4,240	20,175
Industrial	4,600	6,510	11,740	22,850	-	-	22,850	-	22,850	3,010	25,860
Transportation	-	18,050	1,020	19,070	-	-	19,070	-	19,070	20	19,090
Electrical Generation	8,900	3,580	3,800	16,280	2,560	3,570	22,410	-	22,410	(7,270)	-
Synthetic Gas	-	-	-	-	-	-	-	-	-	-	-
Total	13,825	35,090	25,220	74,135	2,560	3,570	80,265	-	-	-	-
1980 Household & Commercial	300	7,720	9,480	17,500	-	-	17,500	320	17,820	6,040	23,860
Industrial	4,750	7,590	12,500	24,840	-	-	24,840	380	25,220	4,170	29,390
Transportation	-	21,440	1,400	22,840	-	-	22,840	-	22,840	30	22,870
Electrical Generation	10,660	5,000	3,600	19,260	6,720	3,990	29,970	-	29,970	(10,240)	-
Synthetic Gas	430	440	-	870	-	-	870	(700)	-	-	-
Total	16,140	42,190	26,980	85,310	6,720	3,990	96,020				
1985 Household & Commercial	100	8,800	10,060	18,960	-	-	18,960	940	19,900	7,800	27,700
Industrial	5,150	9,130	13,240	27,520	-	-	27,520	1,060	28,580	6,290	34,870
Transportation	-	25,450	1,640	27,090	-	-	27,090	-	27,090	40	27,130
Electrical Generation	14,220	6,650	3,450	24,320	11,750	4,320	40,390	-	40,390	(14,130)	-
Synthetic Gas	2,000	670	-	2,670	-	-	2,670	(2,000)	-	-	-
Total	21,470	50,700	28,390	100,560	11,750	4,320	116,630				
2000 Household & Commercial	-	11,120	10,800	21,920	-	-	21,920	2,640	24,560	15,070	39,630
Industrial	6,700	14,660	17,940	39,300	-	-	39,300	2,860	42,160	15,620	57,780
Transportation	-	40,010	2,600	42,610	-	-	42,610	-	42,610	50	42,660
Electrical Generation	17,520	5,040	2,640	25,200	49,230	5,950	80,380	-	80,380	(30,740)	-
Synthetic Gas	7,140	550	-	7,690	-	-	7,690	(5,500)	-	-	-
Total	31,360	71,380	33,980	136,720	49,230	5,950	191,900				

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[1] Includes anthracite, bituminous, and lignite.

[2] Petroleum products refined and processed from crude oil, including still gas, liquefied refinery gas, and natural gas liquids.

Source: U.S. Department of the Interior, op. cit., p. 16.

a. The above table dramatizes the enormous projected U.S. energy requirements which must by and large be satisfied with coal and petroleum.

b. Because of the deficiency in domestic oil supplies, the above statistics may understate the burden ultimately to be placed on coal production, coal being the only resource available in large quantity within the United States.

II. ENVIRONMENTAL IMPACT

A. Direct

1. Air Pollution

a. Coal

Surface coal mining is not a significant contributor to the overall problem of air pollution. Emissions, however, do derive from:

(1) burning of fuels in mining and hauling equipment,

(2) dust and other materials generated during blasting operations,

(3) airborne dust from active and abandoned mines as well as from spoils piles,

(4) fires in abandoned underground coal mines.

b. Oil and Natural Gas

(1) The major sources of air pollution in the exploration, drilling, and production of oil and gas are blowouts and well-testing. The number of blowouts during drilling on land from 1960 through 1970 has been reported to be 100 out of 273,000 wells. Only three significant blowouts have been reported during offshore operations since 1937. As a result of these infrequent events, hydrocarbons are injected directly into the atmosphere, and other combustion products of oil and gas can be emitted if a fire occurs with a blowout. Blowout prevention appears to be the most feasible means to reduce this type of environmental emission.[1]

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[1] Battelle Columbus Laboratories and Battelle Pacific Northwest Laboratories, Environmental Considerations in Future Energy Growth, April 1973, p. 180.

(2) During well-testing, the gas or oil produced is burned, and the products of combustion are released to the environment. With adequate pollution control devices on the burning equipment, the quantities of these emissions can be small.

(3) A comprehensive description of the operations performed in the exploration and production of oil and gas has recently been prepared by the powered vessels used for seismic survey and drilling rig engines. These emissions are expected to be minor.

(4) Estimate of Quantities of Emissions.[1] For the purposes of this study, it will be assumed that the sources of emissions during exploration, drilling and production are the same for offshore and onshore operations. It is further assumed that 25 percent of the oil that is discharged through blowouts and spills is ignited and burns in a manner similar to that in oil-fired burners. Of the remaining 75 percent, 20 percent is assumed to be a volatile fraction that will evaporate into the air. The total emissions from the oil discharges are:

Exhibit F-XII

	Emissions, pounds per barrel of oil discharged		
	Fires(a)	Evaporation	Total
Particulate	1	--	1
SO_2	19	--	19
HC	0.1	38	38.1
CO	0.01	--	0.01
NO_x	2.5	--	2.5

(a) Burning assumed to be the same as residual oil firing in industrial burners. Emission factors from "Compilation of Air Pollutant Emission Factors", (revised), U.S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, North Carolina, February, 1972.

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[1] Ibid.

c. Oil Shale Development

(1) The principal sources of air pollution would be solid particulates resulting from mining and spent shale disposal operations, dust produced during crushing and retorting operations, burning of gases from retorting and refining operations and the generation of electric power, and the dust and vehicle emissions from construction and mining operations.

(2) Estimates by the U.S. Department of Interior for major air pollutants based on a 1,000,000 barrel-per-day scale of operations are as follows:

Dust -- 440 tons per day ≈ 0.88 lb/bbl oil (assuming 98 percent primary dust capture efficiency)

SO_2 -- 460 to 680 tons per day ≈ 0.92 to 1.36 lb/bbl oil

NO_2 -- 80 to 120 tons per day ≈ 0.16 to 0.24 lb/bbl oil.

(3) The operation would, of course, be located in various areas having differing weather conditions. Temperature inversions are typical of the Colorado region, so air quality in certain instances may exceed ambient air standards. Weaver in a recent study has calculated the possible impact on ambient air quality in the central Piceance Creek Basin for a minimum sized plant. Peak ground level concentrations under certain inversion conditions are shown to exceed Colorado air quality standards by appreciable amounts over substantial distances.

The U.S. Department of Interior in its recent report has stated:

> "It is clear...that source emissions to the atmosphere must be so controlled that pollutants would not accumulate under inversion conditions. Wherever feasible, processing facilities should be located on upland services rather than in valleys and canyons."

For Utah locations they conclude that uncontrolled pollutants would tend to affect the Rangely, Colorado, population center. Conversely, inversion conditions in Wyoming are expected to present less of a problem.

(4) The residual concentrations of sulfur are estimated to be 230 to 340 tons per day for a 1 million barrel-per-day operation. This level is calculated to meet minimum standards in the region. Most of these sulfur emissions would occur from burning of the low Btu stack gases from retort operations. Actual levels of sulfur present in these gases would be between 0.9 and 1.1 pounds per million Btu for internal combustion processes, about 5 pounds per million Btu for the indirectly heated process, and 2.8 pounds per million Btu for in-situ combustion. In comparison, the Environmental Protection Agency standards for stationary sources is 0.6 pound per million Btu, while Colorado standards are still lower. It would, therefore, be necessary to establish sulfur removal facilities either through precombustion processes, or stack gas removal of SO_2. Technology exists to accomplish the former, while numerous methods for stack gas removal of SO_2 are in the developmental stage.

(5) The estimated NO_x emissions are primarily a result of combustion techniques, although some additional NO_x also may be formed from chemically bound nitrogen in liquid or solid fuels that may be used.[1]

2. Water Pollution

a. Coal

(1) Surface coal mining can impair water quality in three ways:

- surface water contamination - acid mine pollution and sedimentation
- ground water contamination
- changed water courses

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[1] Battelle, op. cit., pp. 206-207.

(2) Underground coal mining can affect ground water supply and surface water as a result of acid mine drainage.

(3) 281,116 surface acres of water are affected by sedimentation and acid mine drainage. Coal mining is a major contributor to this damage.

(a) Acid mine drainage:

- Sulfuric acid is formed on exposed coal mine surfaces when sulfur-content minerals come in contact with air and water. Waters draining from mines carry sulfuric acid into streams. This process occurs in both abandoned and operating mines; the impact has been most pronounced in bituminous coal mines east of the Mississippi River.

- The current magnitude of acid mine drainage entering 17,000 km of streams and other water bodies is 4 million metric tons of acid. The Bureau of Sport Fisheries and Wildlife estimates that 5,800 miles (57,000 acres) streams and 29,000 acres of impoundments and reservoirs are affected by acid mine drainage from coal mining.

- Other acidic water pollutants are iron and trace metals such as arsenic, copper, lead, manganese, and zinc.

- Siltation from surface mined areas may be 1,000 times that from undisturbed terrain in the Appalachian region.

(b) Sedimentation:

- The magnitude of the impact on water quality caused by sedimentation resulting from strip mining of coal remains unknown.

b. Oil and Natural Gas

(1) Offshore Operations

(a) Sources of oil pollution from offshore production are:

- blowouts of wells
- well leakages
- dumping of oil-based drilling muds
- oil-soaked cuttings
- losses of oil in production
- collisions with offshore structures at drilling sites
- natural damage to offshore structures caused by hurricanes

(b) In offshore operations, the major sources of water pollution are the hydrocarbons released during blowouts and spills, and hydrocarbons discharges with treated waste water.

(c) Oil Spills - Offshore oil production is responsible for 2% of total ocean oil pollution. Currently 18% of U.S. domestic crude oil production comes from the Outer Continental Shelf (OCS), but this percentage is expected to rise substantially since OCS is known to have enormous petroleum resources: 160-190 billion barrels of crude oil and 225-250 trillion cubic feet of natural gas.

(d) Potential Damage- The number of new wells drilled offshore increased from roughly 520 in 1961 to 1130 in 1967. The probability of oil spillage from offshore operations, therefore, more than doubled. The Outer Continental Shelf remains our largest crude oil resource, so danger of oil pollution from offshore structures is ever-increasing.

(2) Onshore Operations

(a) There are several sources of water pollution for onshore operations. The construction of roads for access into prospective petroleum-producing areas could affect runoff when drainage patterns are distrubed or when erosion is possible. Canal dredging can avoid serious or permanent water quality impacts, but it also can result in temporarily increased turbidity and sediment suspension.

(b) The major environmental emissions occur through the entry of oil, chemicals, brine, and waste materials into the water cycle. Spills and leaks allowing such substances to enter the surface or ground water systems can result from human error and neglect, mechanical failures, burning pits and open ditches, and from blowouts. During production, large amounts of saltwater are produced daily from the nation's oil wells. Subsurface disposal is strictly regulated by state water resource agencies, and disposal of saltwater is not permitted in freshwater streams. 1

(3) Estimates of Quantities of Effluents

(a) Based upon the discussion of air pollution, it is estimated that 6×10^{-3} percent of the oil produced is discharged to the environment. If the amount of discharged oil that is released to the air environment is subtracted from this total, about 4×10^{-3} percent of the oil produced appears as a water pollutant.

(b) It appears that up to 4 percent or about 1 million barrels of the saltwater brines may be discharged directly into the environment. Chloride concentrations range from 12 to 50 pounds per barrel and total dissolved solids are on the order of 100 pounds per barrel.

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[1] Battelle, op.cit., p. 191.

[2] Ibid., p. 192.

(4) Turbulence caused by drilling and dredging operations could impair water quality. The magnitude and extent of this problem are unknown and should be further investigated.

c. Oil Shale Development

(1) "The extent of the impact on water quality cannot be measured with any degree of accuracy prior to actual development of a specific operation. Aquifer characteristics and quality of the water produced would be major determinants".[1]

(2) Specific water problem areas may be defined as:

- Lowering of water table in vicinity of the mine.
- Increasing mine depth over time which might entail encountering higher saline waters.
- Erosion and leaching of spent shale deposits.
- Increased salinity in neighboring water bodies.
- Operational spills

3. Ecological Balance

a. Coal

(1) Sedimentation resulting from coal strip mining can reduce sunlight available to green aquatic plants and can curtail development of fish and shellfish populations by covering fish nest, spawn, and food supplies.

(2) Acid mine drainage lowers the pH level which should range between 5.0 and 9.0 for survival of fully developed adult fish. Some species may survive at pH levels below 5.0, but high acidity is usually lethal to fish. Dissolved iron salts in acid mine drainage water can be harmful to fish but datais inconclusive on toxicity of iron to aquatic life.

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[1] Ibid. p. 207.

b. Oil and Natural Gas

(1) The magnitude and extent of the impact of oil spills is still unknown. The most visible effect is large-scale killing of seabirds and fish. But effects of oil pollution on other forms of aquatic life, such as plankton, will require additional research. Long-term impacts on marine and estuarine ecosystems must be determined.

(2) Turbulence associated with offshore drilling for oil and natural gas could impair aquatic life systems, but this problem has apparently not been fully addressed.

c. Oil Shale Development

(1) Noise levels would be substantially increased because of blasting, earth moving equipment, crushing and grinding operations, compressors, pumps, processing operations, etc., involved in this massive industrial operation. This and other factors associated with industrial development would change the character of the region and would have a significant impact on the wildlife presently inhabiting the area. Some species, such as mountain lions, elk, and peregrine and prairie falcon would be intolerant. Others would be affected to a lesser degree.

(2) The impact on fish and other aquatic life would depend on the extent and frequency of water pollution that may occur over time.

4. Solid Waste

a. Coal

-- Problem results from spoils remaining after surface mining. The quantity of waste produced per ton of coal recovered varies greatly from deposit to deposit. Battelle Laboratories in the Appalachian region an average of 33 tons of solid waste produced per ton of coal mined. Solid waste produced in Western surface mines average 17 tons per ton of coal produced.

b. Oil Shale Development

-- Surface mining for oil shale recovery will produce solid waste problems of a magnitude comparable to that associated with surface-mined coal.

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[1] Battelle, op. cit., p. 214.

5. Aesthetic Value

   a. Coal

      --Surface mining activities remove quantities of surface land to uncover coal. Without reclamation practices, topography and vegetation patterns are disrupted; huge scars on the earth's surface result and are glaringly visible for long distances. Resulting acid runoff and sedimentation can severely discolor streams and other water channels.

   b. Oil Shale Development

      --Regions designated for oil shale operation are remote and sparsely developed. Many irreversible changes may result from the emergence of a large-scale oil-shale development, a major one being the destruction of landscapes and historical sites.

6. Noise

   --Noise problems associated with the mineral fuels are associated with the equipment used in the exploration, drilling, and recovery activities. Restrictions on allowable decibel levels would come under the jurisdiction of the Occupational Health and Safety Act.

B. Indirect

1. Coal

   a. Electricity generation - (See ELECTRICITY GENERATION AND TRANSMISSION FACILITIES SITING)

   b. Industrial combustion of coal has major environmental problems associated with it. The most flagrant can be attributed to the iron and steel industry (see IRON AND STEEL MILL METALLURGICAL FURNACES SITING and GRAY IRON FOUNDRIES SITING)

   c. Surface coal mining can impair productivity of valuable domestic agricultural land. Farmers insist that damage done to land can never fully be repaired by reclamation practices even when applied concurrently.

d. Access roads

(1) Mining waste (pyritic) materials used in building access roads can be sources of acidity and can cause surface water pollution.

(2) Designed for heavy equipment transport and mineral loads, these roads have erosion, sediment transport and dust problems since they usually are not paved.

Since many of these roads are located near stream channels, potential for water pollution from sedimentation is increased.

e. Coal cleaning operations which will remove sulfur content of coal in turn create air pollution emissions. Technology exists to control emission levels at ambient levels.

2. Oil

a. Petroleum refining - see PETROLEUM REFINERIES SITING

b. Transportation via waterway and pipeline has potential for water pollution demonstrated most dramatically in the recent offshore tanker oil spills.

c. Transportation via truck has associated motor vehicles emission problems.

d. Storage - see TANK FARM STORAGE VESSEL SITING.

e. Electricity generation - see ELECTRICITY GENERATION AND TRANSMISSION FACILITIES SITING.

f. Chemicals applied to oil-polluted water may in turn endanger aquatic life.

3. Natural Gas

a. Transportation via pipeline suggests the possible contamination of waterways, surface and ground eater with pipeline rupture or leakage.

b. Electricity generation - see ELECTRICITY GENERATION AND TRANSMISSION FACILITIES SITINGS.

III. NON LAND USE VARIABLES

A. Management

1. All Mineral Fuels

a. Cost and availability of energy will have a direct impact on the intensiveness of exploration and mining activity.

b. Federal government policies, especially related to oil and natural gas have in turn ramifications for coal markets:

(1) Pricing - It is absolutely essential that natural gas be brought into alingment with market conditions. Past pricing policies served to deplete domestic natural gas supply while curtailing expansion of coal and oil production capacity.

(2) Imports - The stance on the U.S.'s need for self-sufficiency in oil and gas production has far reaching implications for domestic exploration and drilling for oil and natural gas. National security and balance of payments factors also weigh heavily in governmental decisions on oil and natural fas imports.

(3) Lease sales - These sales can be major incentives for exploration and drilling.

c. Energy Conservation Programs if implemented and enforced could curtail demand for fossil fuels. Such programs include:

(1) Forced cutbacks in electricity consumption.

(2) Incentives for reduced automobile use, etc.

2. Coal

a. General strengthening of state regulatory activities.

(1) Adequate Planning - Prior to starting operations, mining and concurrent reclamation plans should be drawn up and approved to avoid unforseen detrimental environmental impacts.

(2) Stringent, unambiguous performance standards - Specific criteria must be established covering mining techniques (when and where applicable) and water quality and other environmental controls.

b. Reclamation Timing

--It is absolutely essential that reclamation occur concurrently with mining operations (especially when modified block-cut and backfilling techniques are used on slopes). The longer the wait, the larger the damage and higher the cost.

c. Strikes

-- General and wildcat strikes have been serious enough to keep production levels behind demand.

3. Oil

--Oil spills from offshore oil production are currently under careful management of USGS. Dual thrust:

a. Prevential via surveillance to detect leakages and prior analysis of geology, geophysiology, and engineering techniques applied.

b. Prior proof of cleanup capabilities by offshore oil producer.

--Both these steps precede granting of offshore leases and environmental safeguards which must be applied throughout drilling and production operations.

B. Technologies

1. Air Pollution

a. Coal

--Coal mining produces air pollutants-particulates. Dust resulting from blasting and movement of equipment has not been properly analyzed since mining of coal is such a small contributor to overall particulate emissions. Further study in this area might be warranted particularly in regard to human health and particulate settlement patterns.

b. Oil and Natural Gas

--Burners are used to dispose of gas, oil, and emulsions and can be operated without smoke, reducing particulate emissions (Battelle Laboratories).

2. Water Pollution

a. Coal - least damage occurs when:

--deposition of overburden minimized
--concurrent reclamation
--good water management practices

(1) Minimizing deposition of overburden

--Modified block-cut method for contour mining
--Narrow bench auguing with backfilling
--Contour and terrace backfilling

(2) Concurrent reclamation

--Restoring disturbed area to original contour (regrading)
--Restoring topsoil on graded overburden
--Replanting vegetation (may be difficult to revegetate successfully in arid climates)

(3) Water Management - most measures preventive rather than positive control mechanisms

--Surface mining

- installation of settling and impoundment facilities
- froth flotation
- floculation
  filtration (removal of suspended solids and metallic materials)
- mechanically operated sedimentation and clarification basins
- keep as much water as possible out of operating site
- provide proper drainage and removal to treatment facility
- separate contaminated and non-contaminated water
- pH neutralization using lime, limestone, oxidation or some combination of these
- lagooning systems (removal of suspended solids and metallic materials)

--Underground mining

- reduce amount of infiltration into mine
- controlled dewatering to reduce contact with acid-forming materials
- sealing or flooding of inactive mines
- replacement of waste rock
- pH neutralization using lime, limestone, oxidation or some combination of these
- removal of iron and manganese

b. Oil and Natural Gas

(1) The safety devices for offshore operations which are required by OCS regulations include subsurface safety devices high-low pressure shut-in controls, high liquid level shut-in controls, pressure relief valves, automatic fail-close valves at the wellhead, automatic fire-fighting systems, automatic gas detector and alarm systems, and other safety devices on production equipment; high-low pressure sensing devices on pipelines; and blowout preventers, related well-control equipment, and mud system monitoring equipment on drilling wells. Since some of this equipment has been in use for a period of time less than a year, it is not possible to assess quantitatively its effectiveness in reducing pollution.

(2) There is a need for improved technology for cleanup, improved oil spill containment methods, and pollutant recovery equipment and techniques including:

--oil skimming devices not universally available
--chemical solidification of spilled oil
--burning spilled oil on water
--dispersant materials - not yet effective enough to cope with major spill
--refinement of absorbent materials such as plastics
--disposal of recovered materials; reprocessing would be ideal solution

3. Ecological Balance

a. Coal

--Mining practices outlined under water pollution will in turn prevent harm to aquatic life resulting from sedimentation and acid mine drainage.

b. Oil and Natural Gas

--Prevention of oil spills through careful USGS administration will alleviate problems of ecological imbalance.

4. Solid Waste

--Surface coal mining - The following mining and coal methods will substantially reduce solid waste problems associated with coal mining.

- --contour strip mining with backfilling
- --contour mining using modified block-cut
- --long wall surface mining (very expensive process)
- --sediment basins
- --drainage controls

5. Aesthetics

--Coal mining - Imperfect reclamation where mined land does not blend with surrounding topography and vegetation causes visual pollution; use of proper land restoration techniques concurrent with mining operations can prevent visual blight associated with surface coal mining.

6. Potential Substitutes for Mineral Fuels

a. Oil shale development - This substitute for mineral fuels will not be available before 1985. Numerous associated environmental problems with this area are addressed in previous Environmental Impact section.

b. Coal gasification - A potential alternative to natural gas, coal gasification requires coal mining operations and all its associated pollution problems. Benefits are associated with combustion of "syngas" since this process is relatively free of air pollutants.

c. Nuclear power - Utility consumption of fossil fuels will decrease proportionately (through increasing absolutely) as nuclear power plants become more common. By 1990 nuclear power will increase its market share of electricity generation from 3.4% to 37.9% while fossil steam operations will decline from 75.9% to 44.3%.

IV. LAND USE LOCATIONAL STRATEGIES

A. Geographic and Economic Restrictions

Mining is possible only where mineral exists and where mineral is obtainable feasibly and economically.

1. Coal - Domestic Reserves (1967)

Exhibit F-XIII

BILLIONS OF TONS

Region	Total Known Reserves In Place	Economically Recoverable Reserves In Place
Northern Appalachia	115	31
Southern Appalachia	113	24
Eastern Interior	250	125
Western Interior	118	19
Northern Rocky Mountain*	695	153
Southern Rocky Mountain*	170	34
West Coast	6	1
Alaska*	130	?
	1597	~788 → ~544 yield

*Areas with low-sulfur coal reserves; specific states: Montana, Wyoming, Colorado, Alaska.

2. Natural Gas - Domestic Reserves (1970)

Exhibit F-XIV

TRILLIONS OF CUBIC FEET

Area	Total Proven	Total Potential
Alaska	31	327
Appalachia*	7	111
Hugoton-Anadarko	35	96
Permian	28	65
Rocky Mountain	17	88
Southern Louisana	79	145
Other Southwest	22	86
Texas Gulf Coast	62	154
All Other	9	104
TOTAL	290	1,178

* includes offshore Atlantic and Michigan

3. Oil - Domestic Reserves

Total	346	billion barrels
Prudhoe Bay, Alaska	10	billion barrels
Outer Continental Shelf[1]	160-190	billion barrels
	170-200	billion barrels

B. Surface Coal Mining - Ways to Prevent Adverse Environmental Impact

1. Topography - Steep slopes should be avoided in order to prevent erosion problems and subsequent stream sedimentation as well as landslides.

2. Technique Utilized - Conventional strip mining should be prohibited since it fails to control adequately acid mine drainage and sedimentation problems.

3. Rainfall - Aridregions will require more rigorous reclamation efforts, especially in the revegetation process. The costs may outweigh the advantages of siting coal surface mining in such areas.

4. Type of topsoil available for surface layer - Restoration of comparable topsoil is critical in preventing land degradation. Otherwise erosion, sedimentation, and landslides may result. Furthermore, the potential for converting the land to new uses after surface mining will be inhibited.

C. Advantageous Coal Mining Locations

It is desirable to mine in an area where a water pollution control program will be of greater regional benefit than just a reclamation effort. Recreation resources or aquatic life preservation are added incentives for general water restoration and can share the burden of the high pollution control and abatement costs.

D. Multi-Use of Offshore Oil Production Sites

1. Drilling activities could be incorporated with microbiology farms to raise high-protein concentrates for animal feed.

2. Aquaculture programs in conjunction with drilling activities will require systematic planning to avert damage to nets and other fishing equipment.

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[1] Potential areas for offshore oil and gas drilling are: (i) Off U.S. Atlantic Coast: Georges Bank Trough (east of Cape Cod); Baltimore Canyon Trough (oppisite the Delmarva Pennisula); Blake Plateau Trough (off Georgia and Florida); Sable Island (off Nova Scotia). (ii) N.E. Gulf of Mexico (iii) Gulf of Alaska

FUEL MINERALS LAND USE

SUMMARY

1. Timing

   a. The demand for coal is projected to continue unabated through 1985 by which date twice as much coal will be produced per year as is produced currently. The implications for land requirements are enormous.

   b. Both oil and natural gas domestic production is unable to keep pace with domestic demand. The resulting reliance on imports has serious implications for the U.S. balance of payments and for national security.

2. Magnitude

   a. Coal

      (1) As of 1965, 1.3 million acres of land had been strip-mined for coal production. The annual rate of increase in the area of land disturbed by these activities amounted to over 46,000 acres in 1964. The implications for water pollution, solid waste disposal, disturbance of wildlife habitat, and aesthetic degradation are staggering.

      (2) Reclamation techniques are not sufficient to restore the nutrient value of land prior to surface mining. Even if the land may regain its original appearance, its productive capabilities may be severely damaged for years.

   b. Oil and Natural Gas

      (1) Progress is being made in the prevention of oil spills from all causes, but the problem still exists. Technologies to treat polluted waters themselves may degrade water quality and be injurious to wildlife.

      (2) The foreseen development of oil and natural gas reserves on the Outer Continental Shelf, if handled improperly, could be disastrous for coastal land in terms of water pollution, ecological balance, and aesthetic value.

c. Oil Shale Development

The national political pressure to pursue a strategy of self-sufficiency in energy resources could prove irreversibly destructive in the area of oil shale development. While environmental impacts associated with oil shale mining have been identified, their magnitudes are unknown. Extensive research and analysis is vital to the long-term success of developing oil shale resources.

3. Irreversibility

a. 3.2 million acres have been disturbed by surface mining. Coal production accounts for 41% of this land consumption (1.3 million acres) exceeding surface land requirements for any other mineral.

b. Only one third of all land being surface mined has been reclaimed "adequately." Half of the total reclaimed land (roughly one million acres) was restored by man, the other half by nature.

c. Once land has undergone surface mining, no matter how advanced the technology, it cannot regain its original potentialities immediately from reclamation. Geologic stability that has built up over many years is thrown out of balance. Readjustment will be slow. Potentially high-yield agricultural land that is strip-mined will suffer loss of some of its productivity.

4. Present or Potential Conflicts

a. Coal

(1) Surface coal mining versus open space preservation--environmentalists will argue the benefits of leaving land untouched as opposed to ripping it up for coal mining.

(2) Surface coal mining versus agricultural use--coal deposits have been identified beneath land currently devoted to agricultural activities. Even if properly strip mined and reclaimed, the land may never regain its current yield potential.

b. Oil and Natural Gas

(1) Individual state control of the coastal zone within each state's boundaries could impede development of Outer Continental Shelf by private companies.

(2) Pipeline transmission versus waterborne transportation--while tankers may be more economic means of moving oil, pipelines have far fewer associated environmental problems.

5. Chain Effect

a. Coal

The mining of coal is critical to the operation of electrical utilities for generating power. That coal resources be close by is also important. The movement of power plants in the direction of energy complexes could entail combining coal mining and processing facilities on the same site with a coal-fired electricity generating facility.

b. Oil

Petroleum refineries are heavily located near crude oil resources. The development of the Outer Continental Shelf and the Artic regions of Alaska could determine where many future refineries will be located.

6. Urban Versus Rural

Mining of any (fuel) mineral is constrained to those areas where the mineral exists. Most coal mining deposits are in rural areas of the country and have attracted populations to supply manpower requirements. As oil and natural gas production develops on the Outer Continental Shelf and in Alaska, populations will be attracted to these areas. Already heavily populated coastal areas will experience further growth.

7. Concentration Versus Dispersion

Fuel mining in and of itself has minimal direct impact on the tendency of growth to be concentrated or dispersed.

Appendix F
Part 2: ELECTRICITY GENERATION AND TRANSMISSION FACILITIES SITING

I. NEEDS

A. Demand

1. Historically the use of electric power has doubled every ten years. The growth rate in the late sixties accelerated to 9 percent per year.

2. Per capita consumption has been increasing (as of August 1970) roughly five times as fast as population growth.[1]

3. The current shortages in residual fuel oil will have a dampening effect on the supply of electricity, although it is impossible to predict the magnitude of the impact. Some regions dependent on oil-fired installations have been forced to achieve about a 10% reduction in power output.[2]

4. The construction of new oil-fired power generating units will be directly affected by the current energy crisis. It is probably safe to predict an acceleration in the shift away from oil-fired units to nuclear as well as to coal-fired of greater magnitude than that predicted by DOI before shortfalls in oil became evident. Growth in overall generating capacity may be slowed by the energy crisis in light of the uncertain climate for fossil-fuel availability.

B. Supply

1. Actual and Projected Generating Capabilities

(See exhibit on following page.)

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[1] U.S. Office of Science and Technology, Energy Policy Staff. August, 1970.

[2] New England Power Pool. January, 1974.

Exhibit F-XV

Electric Utility Industry - Installed Generating Capacity; net generation and thermal equivalent resource inputs, 1971 actual, and projected to 2000

Period	Installed Generating Capacity - MW	Load Factor	Net Generation Billion KWhrs
1971:			
Fuel burning plants[1]	302,810	.50	1,310
Nuclear plants[2]	8,687	.50	38
Hydropower plants[3]	55,898	.55	266
Total	367,395	.51	1,614
1975:			
Fuel burning plants	350,000	.50	1,540
Nuclear plants	50,000	.55	240
Hydropower plants	80,000	.50	350
Total	480,000	.51	2,130
1980:			
Fuel burning plants	445,000	.50	1,950
Nuclear plants	120,000	.60	630
Hydropower plants	95,000	.50	420
Total	660,000	.52	3,000
1985:			
Fuel burning plants	580,000	.50	2,540
Nuclear plants	215,000	.60	1,130
Hydropower plants	120,000	.45	470
Total	915,000	.52	4,140
2000:			
Fuel burning plants	720,000	.45	2,840
Nuclear plants	960,000	.65	5,470
Hydropower plants	200,000	.40	700
Total	1,880,000	.58	9,010

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[1] Fuel burning plants include steam, internal combustion, and gas turbine plants. Heat rate based on energy inputs to all fuel burning plants.

[2] Energy input for nuclear power converted at an average heat rate based on AEC data for projected nuclear plant mixes.

[3] Hydropower plants include hydro and pumped storage plants. Converted to theoretical energy inputs on the basis of national average heat rates for fossil-fueled steam-electric plants.

Source: U.S. Department of the Interior, Energy Through the Year 2000 (December 1972), Table 8.

a. Gross electricity generation capacity will quintuple between 1971 and 2000 from 367,395 MW to 1,880,000 MW.

b. Net generating capabilities will grow over 5 1/2 times during the same period.

c. Nuclear capacity alone will increase over one hundred-fold, while fossil-fuel and gas turbine operations will only double.

2. Associated Fossil-Fuel Requirements

Exhibit F-XVI
Fossil fuel inputs to the electrical sector, 1971 actual, and projections to the year 2000

	1971	1975	1980	1985	2000
Coal					
Million short tons	331.6	384	460	613	755
Trillion Btu	7,698	8,900	10,660	14,220	17,520
Percent of total	54.1	54.7	55.3	58.5	69.5
Petroleum					
Million barrels	386.9	573	800	1,064	807
Trillion Btu	2,417	3,580	5,000	6,650	5,040
Percent of total	17.0	22.0	26.0	27.3	20.0
Natural gas					
Billion cubic feet	4,000	3,686	3,492	3,346	2,561
Trillion Btu	4,125	3,800	3,600	3,450	2,640
Percent of total	28.9	23.3	18.7	14.2	10.5
Total					
Trillion Btu	14,240	16,280	19,260	24,320	25,200

Source: U.S. Department of Interior, op. cit., Table 10.

a. The relative contributions of the various fossil-fuels will shift more to coal and away from natural gas. Oil-fired operations will remain at proportionately the same level.

b. In absolute terms, demand for each fossil-fuel will:

(1) increase 128 percent for coal,
(2) increase 108 percent for petroleum, and
(3) decrease 36 percent for natural gas.

c. Petroleum needs will start declining absolutely at same point after 1985.

3. Transmission of Electricity

a. Federal Power Commission Estimate

1970 - 300,000 circuit miles of overhead transmission lines

1990 - 150,000 circuit miles of transmission lines ≥ 230 kilovolts

b. In U.S. only one percent of transmission lines (2400 miles) are underground. Most of them are in major urban centers between Boston and Washington.

c. These demand projections will also likely be tempered by the current energy shortage situation.

C. Land Requirements

1. Power Generation

a. Projections

(1) Federal Power Commission projects 300 new power plants (1970-1980: 170; 1981-1990: 130). The majority would have capacities of 2000-3000 megawatts. Advantages of larger size: (i) less costly, (ii) more reliable, and (iii) allows for better environmental control. Cost per large (2000-3000 MW) power plant: $300-400 million.

(2) National Power Survey

Exhibit F-XVII

NEW GENERATING PLANTSITES REQUIRED, BY TYPES OF PLANT, 1971-90

	Number of plantsites		
	1971-80	1981-90	1971-90
Conventional hydro ([illegible] m.w. and above)	15	25	40
Pumped storage hydro ([illegible] m.w. and above)	20	35	55
Fossil steam ([illegible] m.w. and above)	80	60	140
Nuclear ([illegible] m.w. and above)	70	90	160
Total	185	210	395

Source: 1970 National Power Survey, p. I-18-7.

b. Associated Acreage Consumption

(1) The following figures are based on National Power Survey projections for fossil fuel and nuclear power plants only and existing fuel consumption mix before cooling pond requirements:

Exhibit F-XVIII

NUCLEAR AND FOSSIL-FUEL PLANT ACREAGE

Type	No. Plants	Average Acreage	Total Acreage
Nuclear	160	300-500	48,000-80,000
Fossil Fuel			
Coal-fired	83	1200	99,600
Oil-fired	17	200-400	3,400- 6,800
Gas-fired	40	150-300	6,000-12,000
	300		157,000-198,400

(2) By 1990 somewhere in the neighborhood of 150,000 and 200,000 acreas will be consumed by new power plant facilities before cooling pond requirements. Assuming megawatt capacity represented by the 300 new plants above was 900,000 (3000 per plant), another 1,350,000 acres would be necessary if every operation used cooling ponds for control of thermal pollution (assumes 1.5 acres per megawatt of capacity).

(3) This projected acreage estimate would decline relative to the increase in cooling tower vs. cooling pond usage.

2. Power Transmission

a. Circuit Miles of Transmission Lines by U.S. Region

Exhibit F-XIX

(1) By 1990 over half of transmission line circuit miles will be located in the West and the Southeast. The largest additions to existing transmission facilities will also be made in these two regions.

Region	1970	1980	1990
Northeast	7,450	10,850	14,380
East Central	6,160	13,730	17,030
Southeast	7,160	21,770	30,340
South Central	5,700	12,780	21,750
West Central	8,770	14,780	22,060
West	30,130	44,580	53,640
TOTAL	65,370	118,490	159,200

Source: Federal Power Commission

b. Projections - Land Use

Overhead transmission lines require roughly 12 acres per mile. Average width - 110 feet.

(1) Federal Power Commission:
1970 - 4 million acres (110 ft. average width)
1990 - 7 million acres (115 ft. average width)

(2) Department of Interior/Department of Agriculture
2000 - 7.5 million acres
(4.5 million acres new transmission lines)

c. Overhead vs. Underground

(1) Disregarding cost of land, underground cables cost 6-20 times more than overhead with same power carrying capacity.

(2) Achieve economies of scale between overhead and underground lines as approach urban areas where land values are higher. Cost of right-of-way land for underground lines usually negligible.

II. ENVIRONMENTAL IMPACT

A. Direct

1. Air Pollution

a. Emmission problems are associated with the following power generating sources:

(1) Fossil-fuel fried steam generating units

--Coal-fired
--Oil-fired
--Gas-fired

(2) Internal combustion and gas turbine units

b. Power plants account for the following percentages of each air pollutant emitted nationally: (1970):

sulfur oxides	50 percent
nitrogen oxides	25 percent
particulates	25 percent
carbon monoxide	negligible
hydrocarbon	negligible

Source: Office of Science and Technology

c. Sulfur Dioxide

Exhibit F-XX shows the amount of SO_2 emitted per day from a 1000 MW unit operating under base-load conditions with fuels of different sulfur content.

Exhibit F-XX

EMISSION OF SULFUR DIOXIDE FROM CONVENTIONAL FUEL-FIRED POWER PLANTS

Fuel	Sulfur, percent	Heating Value, Btu/lb	Emission of SO_2, tons/1000 MW day(a)
Bituminous coal	2.2	13000	171
Sub-Bituminous coal and lignite	1.5	10000	153
Lignite	0.8	7000	117
Fuel oil	0.5	19500	26

(a) Based on 8500 Btu/kwhr for all fuels.

Source: Battelle Institute, op. cit., Table R-2.

d. Nitrogen Oxides

Exhibit F-XXI

EMISSION OF NITROGEN OXIDES FROM LARGE BOILER FURNACES(a)

Fuel	Average Boiler Rating, MW	NO Emission, ppm Full Load	NO Emission, ppm Intermediate Load	NO Emission, ppm Low Load	NO Emission, tons/1000 MW Day Full Load	NO Emission, tons/1000 MW Day Intermediate Load	NO Emission, tons/1000 MW Day Low Load
Coal	495	990	740	700	95	51	36
Gas	290	590	420	280	31	20	8
Fuel oil	257	360	270	260	17	10	6

(a) Bartok, W., Crawford, A. R., and Piegari, G. J., "Systematic Field Study of NO_x Emission Control Methods for Utility Boilers": E.P.A. Contract CPA 70-90, December 31, 1971, Esso Research and Engineering Company.

e. Particulates

(1) Oil-fired boilers emit small quantities of particulates because of inorganic matter in residual fuel oil, 1 percent of that emitted by coal fired furnaces.

(2) Gas-fired furnaces emit no particulate matter.

(3) Coal-fired boiler furnaces:

Exhibit F-XXII lists the emission of particulate matter from coal-fired boiler furnaces of the three common firing systems assuming that 90% of the mineral matter is captured during combustion by the cyclone furnace, 50% by the slag-tap furnace, and 20% by the dry-bottom furnace.

Exhibit F-XXII
EMISSION OF PARTICULATE MATTER FROM
COAL-FIRED BOILER FURNACES
(10-percent-ash coal; 8500 Btu/kWh)

Type of Firing	Emission from Stack, tons/1000 MW day 50 Percent Collection Efficiency	 99 Percent Collection Efficiency
Cyclone	40	0.8
Slag Tap	200	3.9
Dry Bottom	310	6.2

Source: Battelle Institute, op. cit., Table R-4.

f. Carbon Monoxide

Small amounts of carbon monoxide are emitted by large boiler furnaces, but the emission levels seldom exceed 100 ppm under proper operating conditions. With low excess air and with staged combustion to control NO_2 emission, CO may increase as the limits of satisfactory combustion are reached. An upper level higher than 1000 ppm is unlikely. The emission level at 100 ppm CO would be 9 tons per 1000 MW day. At 1000 ppm, emission would be 90 tons per 1000 MW day, based on 0.084 pound CO per million Btu input and a heat rate of 8500 Btu/kwhr.

g. Hydrocarbons

--Unburned hydrocarbons from oil- or gas-fired boiler furnaces are negligible.

2. Water Pollution

a. Thermal Effects

(1) 80% of heated water discharge in the U.S. comes from power plants. This problem arises from attainable efficiency levels; the average thermal efficiency for electricity generating plants in 1970 was 30%.

(2) Battelle reports that large modern steam-generating power plants presently have reached a plateau in thermal efficiency, no appreciable gains having been reached over the past five years.

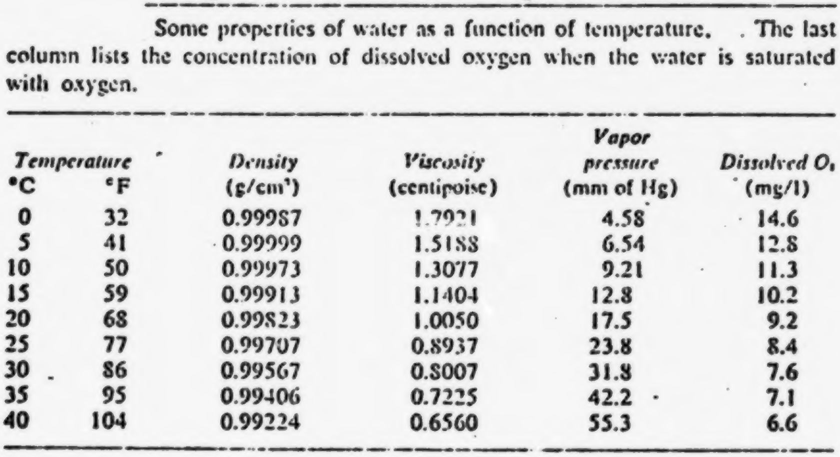
(3) Magnitudes of the thermal pollution impact are unknown. Fish kills are rarely directly associated with power plant operations, yet severe damage may be occurring as a result of temperature changes in water. Better data on this problem is needed.

3. Ecological Balance

a. Directly associated with thermal pollution problems, ecological balance applies as well to conventional and pumped storage hydro operations. Finally, improper siting of transmission facilities can be detrimental to wildlife.

Exhibit F-XXIII

Ecological Imbalances Caused by Thermal Pollution: The Impact of Waste Heat on Aquatic Life



Some properties of water as a function of temperature. The last column lists the concentration of dissolved oxygen when the water is saturated with oxygen.

Temperature °C	°F	*Density* (g/cm^3)	*Viscosity* (centipoise)	*Vapor pressure* (mm of Hg)	*Dissolved O$_2$* (mg/l)
0	32	0.99987	1.7921	4.58	14.6
5	41	0.99999	1.5188	6.54	12.8
10	50	0.99973	1.3077	9.21	11.3
15	59	0.99913	1.1404	12.8	10.2
20	68	0.99823	1.0050	17.5	9.2
25	77	0.99707	0.8937	23.8	8.4
30	86	0.99567	0.8007	31.8	7.6
35	95	0.99406	0.7225	42.2	7.1
40	104	0.99224	0.6560	55.3	6.6

b. Effects of increased water temperatures include:

(1) Decreases in water viscosity and density, resulting in increased settling speeds of suspended particles; stream settlement loads will tend to settle more rapidly which could affect aquatic food supplies.

(2) Above 35° C, fish life may be seriously endangered due to lower solubility of oxygen; fish require at minimum 5 mg. per liter to survive and 7 mg. per liter in spawning areas.

(3) High temperatures also favor bacterial growth and eutrophication, accelerate physiological processes (reproduction) and decomposition of oxygen-demanding wastes; result will be aggravation of existing oxygen depletion problem, in addition to having a direct impact on migratory patterns of aquatic life.

c. Ecological Imbalances caused primarily by conventional hydro and pumped storage hydro power plants

(1) Pressure levels - will rise as a result of pumping and deep intake/shallow discharge operations. Will fall as a result of shallow intake/deep discharge operations.

(2) Turbulence - jet discharges may cause disorientation in organisms hence affecting predator-prey relationships.

(3) Mechanical - impingement of invertebrates and fish on intake screening; also abrasion and damage of specimens passing through intake structures and cooling system.

Magnitudes of these variables (quantities of species maimed or killed) not available. Technology does exist to minimize harm to aquatic life.

d. Power Transmission and ecological balance

The danger refers to interference of migratory bird traffic and interruptions in movement patterns of other wildlife. This impact is easily controllable if proper analysis is made prior to installation so transmission lines will not disrupt wildlife activities.

4. Solid Wastes

   a. Coal-fired fossil fuel plants generate several million cubic feet of collectible ash (10-15% of coal burned). Even with 99% removal of fly ash particulates, 7000 tons would still be discharged into the air each year from a 3000 megawatt coal burning station. Such a plant would require 300-400 acres to store ash piled to average depth of 25 feet.

   b. Oil- and Gas-fired fossil fuel plants, though not as serious offenders as goal-fired plants, still generate fly ash which must be collected and properly disposed.

5. Noise

   a. Power generation - noise is controllable by use of insulating materials in construction. The problem is not acute enough to warrant major study. Most power plants are removed adequately from population centers.

   b. Power transmission - the hum associated with power lines may be irritating to people located close by; it can be controlled by siting lines where possible away from homes and human activity centers.

6. Aesthetic Value

   a. Power plants - good design and imaginative landscaping can reduce the ugliness of power plants.

   b. Transmission lines - this aspect is a critical source of visual pollution. Underground systems are the solution but they are too expensive currently.

B. Indirect

1. Fossil Fuel Mining (see FUEL MINERALS SITING)

2. Preparation of Fossil Fuels for Powerpland Use

   a. Petroleum Refineries (see PETROLEUM REFINERY SITING)

   b. Coal Desulfurization (pre-combustion) - some of the high sulfur content coal used in power generation is "cleaned." The thermal drying operation used for the coal cleaning process is itself a major source of air pollution.

   c. Stack Gas Cleaning (post-combustion) - the process used to remove fly ash and sulfur from coal-burning plant operations creates additional heat energy and ultimately aggrevates thermal pollution problem.

   d. Oil Desulfurization - this process is presumably a source of air pollution as is coal desulfurization although no statistics are available on emissions associated with oil desulfurization.

3. Fossil Fuel Transport
   Environmental impact basically negligible:

   a. Oil spills - power generation needs only are of host of contributing factors.

   b. Fossil fuel deliveries - oil/natural gas generally is delivered by pipeline; coal generally by rail. Trucks have a minimal role here but should be recognized anyway because of their emission, particularly if rail freight traffic continues to decline.

III. NONLAND USE CONTROLS ON ENVIRONMENTAL IMPACT

A. Management

1. For fossil-fuel fired and internal combustion generating units only, low sulfur content fuels should be used.

2. Precautionary operating and maintenance practices should be emphasized by individual utilities.

B. Technology

1. Air Pollution (applies only to steam electric power plants--fossil fuel and internal combustion operations)

   a. Particulate control
   mechanical collectors (flue gas filters and scrubbers)
   electrostatic precipitators

   b. Sulfur oxide control

      (1) Stack gas cleaning

         (a) Well over 50 individual processes for removing SO_2 from stack gas have been identified.

         (b) Typical of the throwaway processes is wet limestone scrubbing and typical of the recovery processes are MgO scrubbing with H_2SO_4 production and alkali scrubbing (sodium or amonium salts) with sulfur production.

         (c) The removal efficiencies for SO_2, NO_x, and fly ash are assumed to be linear functions of time during the period 1975 to 1990 with a range of 75 to 90 percent for SO_2, 0 to 20 percent for NO_x, and 99 to 99.5 percent for fly ash.

         (d) Stack gas cleaning will provide the only means for reducing emission from the 30 to 50 percent of the existing coal and oil fired plants where low sulfur fuels will not be available.

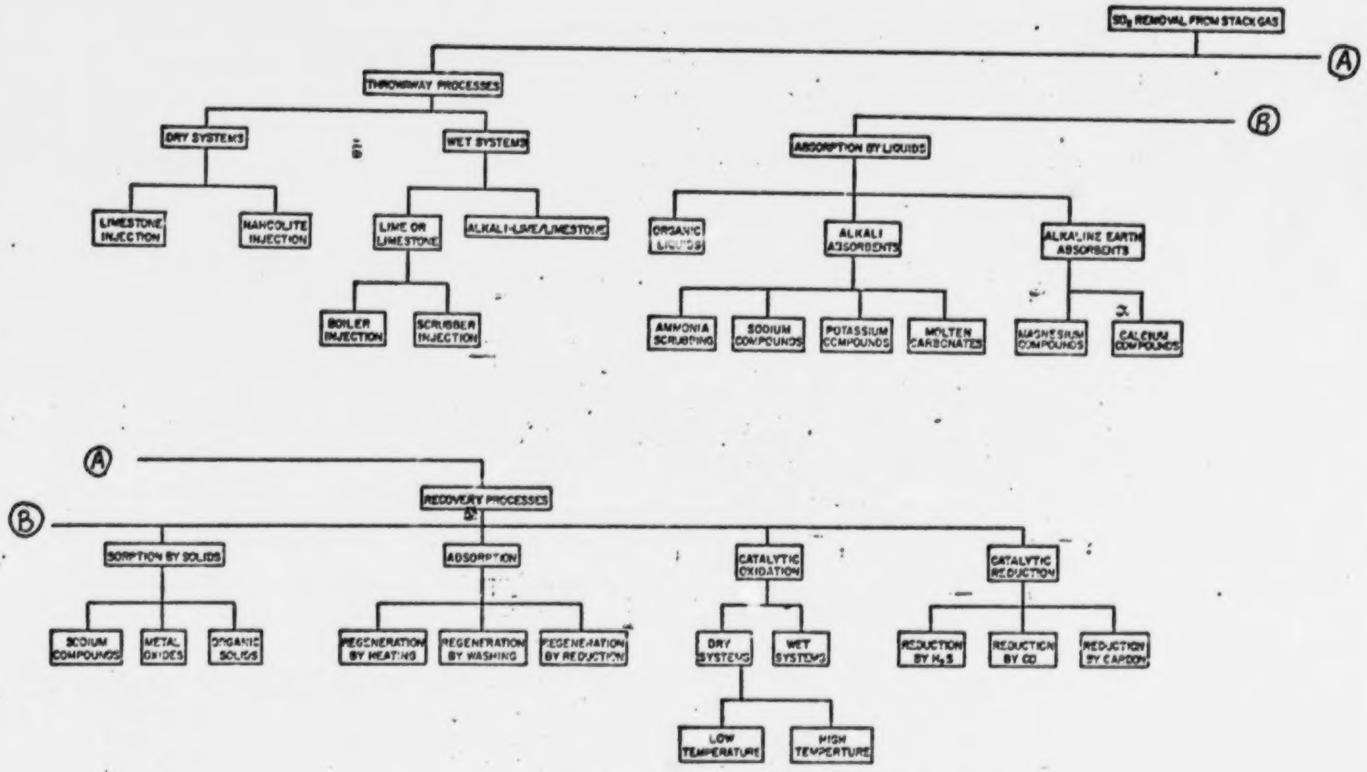

SO$_2$ REMOVAL FROM STACK GAS
Ⓐ
THROWAWAY PROCESSES
DRY SYSTEMS
WET SYSTEMS
LIMESTONE INJECTION
NAHCOLITE INJECTION
LIME OR LIMESTONE
ALKALI-LIME/LIMESTONE
BOILER INJECTION
SCRUBBER INJECTION
Ⓑ
ABSORPTION BY LIQUIDS
ORGANIC LIQUIDS
ALKALI ABSORBENTS
ALKALINE EARTH ABSORBENTS
AMMONIA SCRUBBING
SODIUM COMPOUNDS
POTASSIUM COMPOUNDS
MOLTEN CARBONATES
MAGNESIUM COMPOUNDS
CALCIUM COMPOUNDS
Ⓐ
RECOVERY PROCESSES
Ⓑ
SORPTION BY SOLIDS
ADSORPTION
CATALYTIC OXIDATION
CATALYTIC REDUCTION
SODIUM COMPOUNDS
METAL OXIDES
ORGANIC SOLIDS
REGENERATION BY HEATING
REGENERATION BY WASHING
REGENERATION BY REDUCTION
DRY SYSTEMS
WET SYSTEMS
LOW TEMPERATURE
HIGH TEMPERTURE
REDUCTION BY H$_2$S
REDUCTION BY CO
REDUCTION BY CARBON

Exhibit F-XXVII. TECHNOLOGIES FOR THE REMOVAL OF SO$_2$ FROM STACK GAS

(2) Pre-combustion desulfurization of oil and coal

(3) Gasification of coal and oil

c. NO$_x$ control
(1) flue-gas recirculation
(2) off-stoichiometric combustion techniques
(3) low excess combustion air
(4) reduced combustion air preheat

2. Water Pollution / Ecological Balance } Control of Thermal Pollution

a. cooling ponds - natural and artificial

b. wet cooling towers (natural draft and mechanical draft)

c. dry cooling towers (non evaporative)

d. air conditioning and refrigeration systems - technology exists but has not been applied to heated wastewater problem.

e. constructive applications for heated wastewater
   (1) heating systems for buildings
   (2) heated swimming pools
   (3) deicing of waterways
   (4) desalination
   (5) aquaculture - spawning grounds for fish or shellfish
   (6) agriculture - warm water irrigation

3. Ecological Balance - Problems Other than Thermal Pollution

--Pressure, turbulence, and mechanical obstruction -- all these variables can be effectively controlled by design and minimizing intake-discharge depth differentials.

4. Noise

--Design controls (use of insulating materials)

5. Aesthetic Value

a. Power plants - design controls

b. Transmission Lines

(1) Underground - short-term solutions (c. 1975)
synthetic polymers for high power capacity cables
compressed gas insulated cables

(2) Underground - long-term solutions (1980's)
cryoresistive cables
super-conducting cable (niobium or niobium-tin)
direct current transmission for long distance

IV. LAND USE/LOCATIONAL STRATEGIES TO MINIMIZE ENVIRONMENTAL IMPACT

A. Generation Facilities

1. Site power plants underground -- especially advisable for nuclear plants to avoid possibility of radiation contamination as well.

2. Create buffer zone around power plant using landscaping to screen facility.

3. Offshore siting.

4. Multipurpose siting

   a. Utility complex where combine solid waste disposal facility and/or sewage treatment plant with electricity generating unit. Could use solid waste or sewage sludge to fire power plant. Environmental problems of one operation might be eliminated or reduced by juxtaposition of another that could avail itself of former's waste products.

   b. Energy complex--possible suggested activity combinations:

      (1) Power plant with coal mine and coal cleaning or coal gasification plant.

      (2) Power plant with petroleum refinery and petrochemical plant.

   c. These operations colocated would eliminate transport problems. Acreage might be conserved by their collocation as opposed to their combined total land consumption as separate operations.

B. Transmission Systems

1. Utility Corridors

   --Combine transmission operations of more than one utility. Must take into account probability of inductive interference if combining power and communication lines, also corrosion.

2. Nonutility Multiple Uses on Rights-of-Way
   - a. Railroad Transportation
   - b. Recreation facilities (e.g., bicycle path, hiking trail)
   - c. Parks
   - d. Orchards
   - e. Agricultural activities (e.g., Christmas tree nursery)

3. Siting Criteria for Reducing Visual Pollution
   - a. Highways
     - (1) Site lines crossing main roads away from intersections and interchanges.
     - (2) In view of highway, provide topographical background or screen lines with vegetation or terrain.
   - b. Timber areas and forests
     - (1) Place timber areas and forests beyond ridges.
     - (2) Use long span towers when crossing highways.
     - (3) Prevent right-of-way tunnels by deflecting path from straight line.
   - c. Steep slopes and canyons
     - (1) Hills - avoid siting along crests.
     - (2) Canyons - avoid running directly down canyon walls.
   - d. Avoid open expanses of water or marshland.
   - e. Avoid flight lines of migratory birds or areas of wildlife concentration.

SUMMARY: ELECTRICITY GENERATION AND TRANSMISSION FACILITIES SITING

1. Timing

a. Demand for electricity is rising rapidly and by 1990 will more than triple the 344,000 megawatts consumed in 1970. Some 300 additional major (2000 - 3000 megawatt capacity) generating plants will be required by 1990. Over half (160) will be nuclear-powered. An additional 3 million acres of high voltage transmission line rights-of-way will also be needed.

b. Delays in facility construction aggravate an existing shortage; brownouts and blackouts have occurred during peak use periods.

2. Magnitude

a. BACT for sulfur oxide emissions is only 95 percent effective on fossil-fuel power plant necessitating siting in areas that are relatively emission-free, or along coastlines or offshore where prevailing winds will keep pollutants from the land.

b. Thermal pollution can be controlled by cooling towers, a far preferable solution to cooling ponds which consume enormous quantities of land. The towers themselves, however, create fog, emit particulates, and are a source of noise and visual pollution.

c. The preference for coal-fired units among fossil-fuel power plants necessitates added land consumption for ash disposal.

3. Irreversibility

a. Power plants are only a small part of very complex energy supply network. Once installed, electricity generation and transmission facilities are difficult and costly to remove.

b. Until underground transmission technologies become feasible and economically viable, the visual blight of power lines will continue. Precautionary siting can abate but not remove the threat to aesthetic value.

4. Present or Potential Conflicts

   a. Currently the tension between energy needs and environmental impacts of supplying those needs has brought projects to a standstill. Opposition to power plants will undoubtedly go in direct proportion to the rising demand for electricity; yet electrical needs must be provided or the country will be faced with brownouts and blackouts.

   b. The responsibility for decision-making regarding review and approval procedures on electricity generation and transmission facilities has been dispersed through a proliferation of agencies. No systematic mechanism exists to expedite administration. Certain levels of government should lose their authority in the decision-making process in order to accelerate the construction of much needed facilities.

   c. Requirements for low-sulfur fuels: desulfurization vs. mining of low-sulfur resources. Needs may be so great that both processes will be utilized. Transport costs of low-sulfur coal from Western areas where it can be mined will deter Eastern markets.

   d. Coastal vs. inland siting of power plants - if power plants are sited along coastlines, valuable open space and recreational lands will be lost. Recently in California conservationists were responsible for forcing a nuclear power plant inland from a planned coastal location.

5. Chain Effect

   Electricity generation facilities, particularly fossil fuel power plants, are becoming part of larger energy complexes. Economics can be achieved by locating power plants near the fuel resources they require; furthermore, fuel storage facilities, any fuel treatment operations necessary to reduce air pollutants to ambient levels, and waste disposal facilities should also be incorporated on-site. The result is an enormous land consumer capable of attracting a population of workers requiring housing and other amenities.

6. Nondegradation

   a. Air--power plants will be the primary threat to maintenance of existing air quality levels in pristine areas.

b. Water--heated water discharges into water bodies from nuclear and fossil-fuel generating units would violate a nondegradation policy.

7. Urban vs. Rural

a. Sitimg power plants away from population centers is dependent on flexible and efficient transmission systems. Economies of scale currently favor locations fairly close to load centers.

b. Rural siting of power facilities can have direct impact on population growth in rural areas, especially if mining and other processes are located on-site with the power plant. Manpower needs will draw residential and commercial development to such an energy complex.

8. Concentration vs. Dispersion

a. A trade-off exists between a population concentrated in urban areas requiring less circuit miles of transmission line but overloading existing carrying capacities vs. a population dispersed over large area necessitating additional circuit miles of transmission lines but alleviating loads at urban centers.

b. Dispersion strategies create strain on primary energy fuel resources. Living in areas of dispersed population necessitates automotive use rather than mass transit. Petroleum products that potentially could be used for electric power generation thus would go to motor vehicle transportation, a shift in refinery allocations away from residual fuel production to more gasoline.

Appendix F
Part 3: PETROLEUM REFINERY SITING

I. NEEDS

A. Domestic Consumption of Petroleum

1. Consumption of oil grew at an annual compound rate of about 4% during the decades of the 50's and the 60's. During the 1970's, this rate is expected to increase approximately 3.8%.

2. Petroleum is expected to slightly decrease its share of total fuel consumption from 44.2% in 1971 to 43.9% in 1980 and 37.2% by the year 2000. (Calculated from table given in Exhibit F-XXVIII.)

Exhibit F XXVIII
Projected Consumption By Energy Source
[In trillions of BTU's]

Energy Source	1971[1]	1975	1980	1985	2000
Coal	12,560	13,825	16,140	21,470	31,360
Petroleum	30,492	35,090	42,190	50,700	71,380
Natural Gas	22,734	25,220	26,980	28,390	33,980
Nuclear Power	405	2,560	6,720	11,750	49,230
Hydropower	2,798	3,570	3,990	4,320	5,950
Total	68,989	80,265	96,020	116,630	191,900

[1] Actual

Source: U.S. Department of the Interior, U.S. Energy Through the Year 2000. December 1972, p. 8.

B. Petroleum Supply Forecast

1. In 1971 domestic supply accounted for 74.0% of U.S. petroleum consumption, with imports accounting for the remaining 26.0%.

2. DOI foresees the following sources of domestic supply, if present trends continue, accounting for 29.7% of total projected demand by the year 2000.[1]

   a. 16.9% from lower 48 supply

   b. 10.0% from Alaskan North Slope oil

   c. 2.8% from synthetic liquids

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[1] U.S. Department of the Interior. U.S. Energy Through the Year 2000. December 1972, p. 31.

3. Between now and 1980, supplemental supplies (see Exhibit II) must come from imported oil or increased domestic production.

4. Beyond 1980, supplemental supplies may also come from shale oil, tar sands and coal liquefaction.

Exhibit F XXIX

. Estimated Petroleum supply schedule, 1971 actual with projections to the year 2000

	1971	1975	1980	1985	2000
Total Supply:					
Million Barrels	5,523	6,340	7,615	9,140	12,985
Million Barrels/Day	15.1	17.4	20.8	25.0	35.5
Trillion Btu	30,492	35,090	42,190	50,700	71,380
Domestic Supply:					
Lower 48 Supply[1]					
Million barrels	4,117	4,000	3,740	3,345	2,200
Million Barrels per day	11.3	11.0	10.2	9.2	6.0
Trillion Btu	22,569	22,130	20,720	18,550	12,090
Alaskan North Slope					
Million Barrels	-----	-----	550	730	1,295
Million Barrels per day	-----	-----	1.5	2.0	3.5
Trillion Btu	-----	-----	3,050	4,050	7,120
Synthetic Liquids					
Million Barrels	-----	-----	-----	180	365
Million Barrels per day	-----	-----	-----	0.5	1.0
Trillion Btu	-----	-----	-----	1,000	2,010
Total Domestic Supply					
Million Barrels	4,117	4,000	4,290	4,255	3,860
Million Barrels per day	11.3	11.0	11.7	11.7	10.5
Trillion Btu	22,569	22,130	23,770	23,600	21,220
Supplemental Supplies[2]					
Million Barrels	[3] 1,406	[3] 2,340	[3] 3,325	4,885	9,125
Million Barrels per day	3.9	6.4	9.1	13.3	25.0
Trillion Btu	7,923	12,960	18,420	27,100	50,160
Percent of Total Supply	26.0	36.9	43.7	53.4	70.3

[1] Includes crude oil and natural gas liquids.
[2] May be from imports, shale oil, coal liquefaction, etc. See text for discussion.
[3] All imports.

Source: U.S. Department of the Interior, U.S. Energy Through the Year 2000, December 1972, p. 31.

B. Refining Capacity

1. As of January 1, 1972, there were 282 refineries in the States, 250 of which were operating; also 3 operations in Puerto Rico. Roughly 60% of U.S. facilities are located at the tidewater and most of these are along the Gulf Coast.

Capacities: 13,437,468 bbl/day - U.S. total
13,034,818 bbl/day - U.S. operating
218,800 bbl/day - Puerto Rico

2. As of January 1, 1972, 257,470 barrels-per-day capacity under construction, of which 34,000 barrels per day are for replacement (13.2% of total); remainder is expansion.

3. Distribution of operating capacity (January 1, 1972) by major states as a percent of total U.S. & Puerto Rico operating capacity:[1]

Exhibit F-XXX
Distribution of Petroleum Refinery Operating Capacity

Texas	26%
California	13%
Louisiana	11%
Illinois	7%
Pennsylvania	5%
New Jersey	4%
Indiana	4%
Ohio	4%
TOTAL	74%

4. Number and capacity of refineries in U.S. and Puerto Rico, by state and by region: total. operating, operable, new building are shown in Exhibit F-XXXI.

5. Structure of Petroleum Refinery Industry - Concentrated industry-ownership by approximately 130 firms. Sixteen firms account for 80% of total capacity in 105 refineries, each larger than 200,000 bbl/day. Half of total refineries less than 25,000 bbl/day and constitute 8% of total capacity.

6. There has been a widening gap between domestic supply and demand for refined petroleum.

   a. Refining capacity as tabulated by a 1973 Oil and Gas Journal survey is about 13 million bbl/day; reports that refined product consumption for 1972 exceeded 16 million bbl/day.

   b. If the typical capacity of a new refinery is taken as 250,000 bbl/day, 12 new refineries are needed to supply present demand.

   c. DOI estimates indicate that 1985 oil products demand will be 25 million bbl/day; 36 typical new refineries will be needed, as well as additional capacity for replacement and modernization of older facilities.[2]

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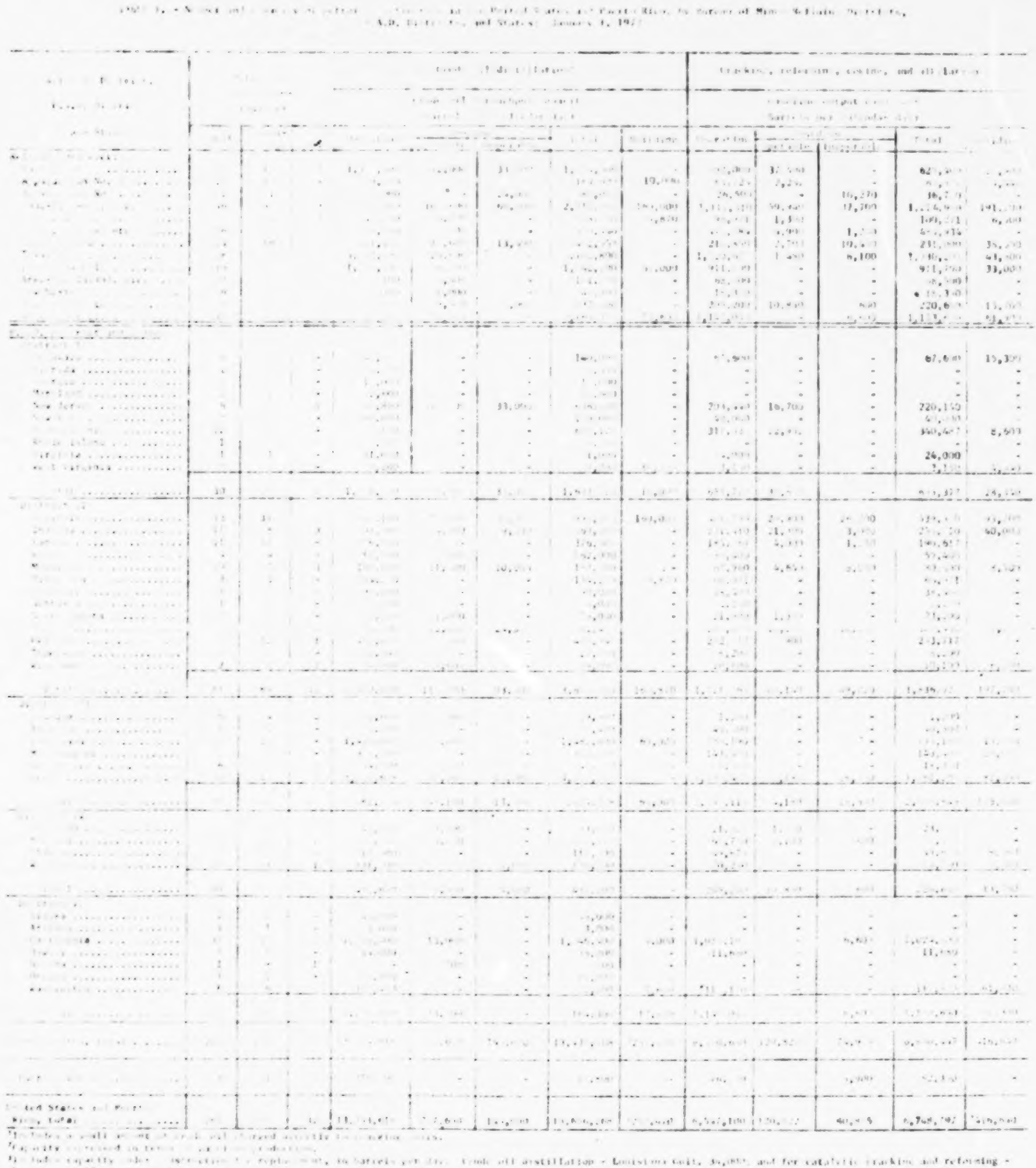
[1] U.S. Bureau of Mines. March 1972.

[2] Radian Corp. A Program to Investigate Various Factors in Refinery Siting (Texas 1973), p. II-1.

Exhibit F-XXXI
Number and Capacity of Petroleum Refineries, 1972



Source: Bureau of Mines, op.cit. page 3

C. Refinery Expansion and Grass Roots Construction

1. U.S. Refinery Construction Policy

The President's Energy Message of April 18, 1973 stated a policy of encouragement for construction of the required refining facilities. Recent shortages of refined products have served to reemphasize the need.

2. Time Element

a. For grass roots construction an average lead time of 2-3 years is involved, after the project has been approved.

b. This means that about 6 refinery construction starts are required annually for the next 10 years (see Exhibit F-XXXII).

c. In order to catch up with the current shortfall, a larger number of starts may be indicated for the next few years.[1]

3. Land Requirements

a. Ratios were developed by RPA for each primary activity as a function of the required production capacity storage capacity and expansion (including greenbelt) needs:

Exhibit F-XXXII

• Base case refineries (tanker fed, 15-day)	6 acres/ 1,000 bbl/day
• Offshore-supplied refineries (10-day storage)	5 acres/ 1,000 bbl/day

b. For an average size refinery in 1985 of 200,000 bbl/day from 1,000 to 1,200 acres will be needed, not including an associated petrochemical complex which may require an additional 300 to 350 acres per complex.[2]

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[1] Radian, op. cit. p. II-1.

[2] RPA, Part II, p. 7.

Exhibit F-XXXIII
Refinery Construction Plans

DEFINITE PROJECTS[1]

Location	Magnitude of Expansion (Barrels/day)	Operation Date
Texas		
Baytown	250,000	Late 1976
Port Arthur	30,000	A.S.A.P.
Corpus Christi	20,000	Early 1974
Houston	95,000	1976
Louisiana		
Convent	200,000	Mid-1977
Baton Rouge	50,000	1974
New Jersey		
Paulsboro	100,000	1977-1978
Perth Amboy	75,000	July 1975
Bayway	50,000	Late 1976
Baytown	250,000	Late 1976
Baytown	50,000	1974
California		
Richmond	175,000	September 1975
Watson	20,000	Early 1974
El Segundo	175,000	October 1975
Illinois		
Hartford	45,000	Late 1974
Pennsylvania		
Philadelphia	25,000	Late 1973
Kansas		
Arkansas City	20,000	Late 1974
Alabama		
Tuscaloosa	15,000	
New Mexico		
Artesia	6,000	May 1974
Mississippi		
Pascagoula	60,000	January 1975
TOTAL	1,711,000	

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[1] Oil and Gas Journal, August 6, 1973 and December 10, 1973.

Exhibit F-XXXIII (Cont'd)

PROJECTS UNDER STUDY

Location	Magnitude of Expansion (Barrels/day)	Operation Date
Louisiana		
New Orleans	200,000	New Plant
Geismar	200,000	New Plant
Mississippi		
Pascagoula	150,000	New Plant
Alabama		
Mobile	120,000	New Plant
Illinois		
Robinson	75,000	Expansion
Texas		
Houston	72,000	Expansion
Deer Park	?	Expansion
Oklahoma		
Wynnewood	34,000	Expansion
Oregon		
Portland	?	New Plant[1]
New Hampshire		
Portsmouth	250,000	New Plant
Newington	100,000	New Plant[2]
?	200,000	New Plant[2]
New Jersey		
Pedricktown	150,000	New Plant[3]
Maine		
Sanford	250,000	New Plant[4]

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[1] Oil and Gas Journal, August 6, 1973

[2] Boston Globe, September 13, 1973

[3] New York Times, October 9, 1973

[4] Boston Globe, October 18, 1973

4. Locational Trends

   a. Historically refineries in the U.S. have located close to sources of crude oil production, along coastal zones for accessibility to tanker transportation, and also near large inland population concentrations and pipelines.

   b. Refineries are primarily clustered in 3 large group(s) within the Gulf Coast/South West region, and in 4 smaller group(s) located in the Mid-Atlantic, Great Lakes, North West and Southern West Coast regions.

   c. Recently petroleum refining is becoming more "market oriented" rather than "raw material" oriented due to the fact that transportation of crude to the refinery is less costly than transportation of products to the market.

   d. New refineries will tend to be located in the vicinity of the large metropolitan markets such as the East Coast, along the Great Lakes, the West Coast, and the Gulf Coast.[1]

   e. Coastal sites will continue to be attractive.

      (1) Many large population centers are near or within coastal zones.

      (2) Future sources of crude in U.S. probably lie along continental shelf around the U.S.

Exhibit F-XXXIII
1972 Estimated Recoverable Reserves

Total	346	billion barrels
Prudhoe Bay Alaska	10	billion barrels
Outer Continental Shelf	160-190	billion barrels

      (3) Coastal sites offer greater flexibility in terms of alternative crude supplies.

II. ENVIRONMENTAL IMPACT

A. Direct

1. Air Pollution

a. Hydrocarbons (HC)

(1) Hydrocarbon emissions from petroleum refineries may range from 0.1 to 0.6 weight percent of the crude oil processed according to a 1969 report by the U.S. Department of Health, Education & Welfare.

(2) The equivalent of 0.1 weight percent is about 345 pounds hydrocarbon emissions/1,000 barrels; although California refineries using BACT were achieving an emission factor of 140 pounds hydrocarbon/1,000 barrels crude oil in 1970.[1]

(3) In 1967, the level of hydrocarbon emissions for petroleum refineries was 153,000 tons/ year.

(4) In 1973, EPA has reason to suspect that all existing refineries are exceeding primary ambient air quality standards for hydrocarbon.

(5) EPA expects the total level of emissions to increase to 195,000 tons/year by 1977.

(6) Major sources of hydrocarbon emissions are the following refining processes:

(a) During crude oil processing, or separation, the barometric condense on the vacuum distillation column allows non-condensable light hydrocarbons to pass through the atmosphere. The quantity of emissions is a function of the unit size, type of feedstock and cooling water temperature.

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[1] Battelle, *op. cit.*, p. 300.

(b) Hydrocarbons are released during converting

(i) during catalytic cracking, especially in the widely used fluid cracking units (220 lb/10^3 bbl fresh feed) but also in other methods such as moving bed catalytic cracking units (87 lb/10^3 bbl fresh feed).

(ii) during processes of polymerization, alkylation, and isomerization, due to the difficulties in sealing valve stems and pump shafts.

(c) Hydrocarbons are released during treating

(i) during treating operations emission levels depend on the methods of handling spent acid and acid sludges and of recovering or disposing of hydrogen sulfide.

(ii) during catalyst regeneration, air agitation in mixing tanks, and other blowing operations.

(d) From storage tanks

b. Sulfur Dioxide (SO_2)

(1) SO_2 is emitted from refineries as a result of combustion of sulfur-containing fuel ; if the sulfur in the fuel can be minimized, the resulting SO_2 is minimized.

(2) Exhibit F-XXXIV shows the variations in refinery SO_2 emissions that can be expected with different types of refinery fuel and different crude sources.

(3) In 1967, 2,310,000 tons of SO_2 were emitted from petroleum refineries.

c. Particulates

(1) The major potential source is the catalyst fines from catalytic cracking.

(2) Lesser sources of particulate emissions are combustion and possibly coking operations.

(3) The standard emission factor for catalyst of particulates from fluid catalytic cracking units is 61 pounds/thousand bbls crude.

Exhibit F-XXXIV

Estimated Refinery Sulfur Dioxide Emissions

Refinery Fuel	Crude Source	Crude Gravity, °API	Sulfur Content, %	SO_2 Emissions, lb/1000 bbl	
				Pre-1975	Post-1975
Natural gas	Nigeria (Delta)	31.0	0.18	54	43
	1966 mix		0.76	345	183
	Alaska (Prudhoe-Bay)	27.0	0.86	383	207
	Venezuela (Tia Juana)	27.0	1.5	680	360
	Saudi Arabian mix	34.9	1.63	740	392
	Kuwait	31.4	2.5	1,140	600
Residual (0.75% S)	Nigeria (Delta)			404	393
	1966 mix			695	533
	Alaska (Prudhoe Bay)			733	557
	Venezuela (Tia Juana)			1,030	710
	Saudi Arabian mix			1,090	742
	Kuwait			1,490	950
Residual (2.3 x Crude %S)	Nigeria (Delta)			248	237
	1966 mix			1,261	999
	Alaska			1,308	1,132
	Venezuela			2,290	1,970
	Saudi Arabian mix			2,490	2,142
	Kuwait			3,820	3,280

Source: Battelle, p.298

(4) In 1967, 185,000 tons of particulates were released to the atmosphere from petroleum refineries.

d. Carbon Monoxide (CO)

(1) The only significant source of CO emissions in the petroleum refinery is the catalytic cracking catalyst regenerator

(2) In 1967, 9,300,000 tons of CO were released by refineries.

e. Nitrogen Oxides (NO_x)

(1) The major source of NO_x in refineries is in combustion operations

(2) Refineries contribute a relatively small proportion of the national NO_x emissions.

f. Odors

(1) Refining can produce a number of malodorous compounds (generally sulfides, amines, adehydes, and phenols).

(2) Many of these can be detected at concentrations of one part/billion or less

2. Water Pollution

a. Major effluents include ammonia, BOD, chromate sulfide and oil.

b. The major sources of effluents are shown in Exhibit VIII.

c. Refineries differ significantly in volumes of effluents depending upon various factors including:

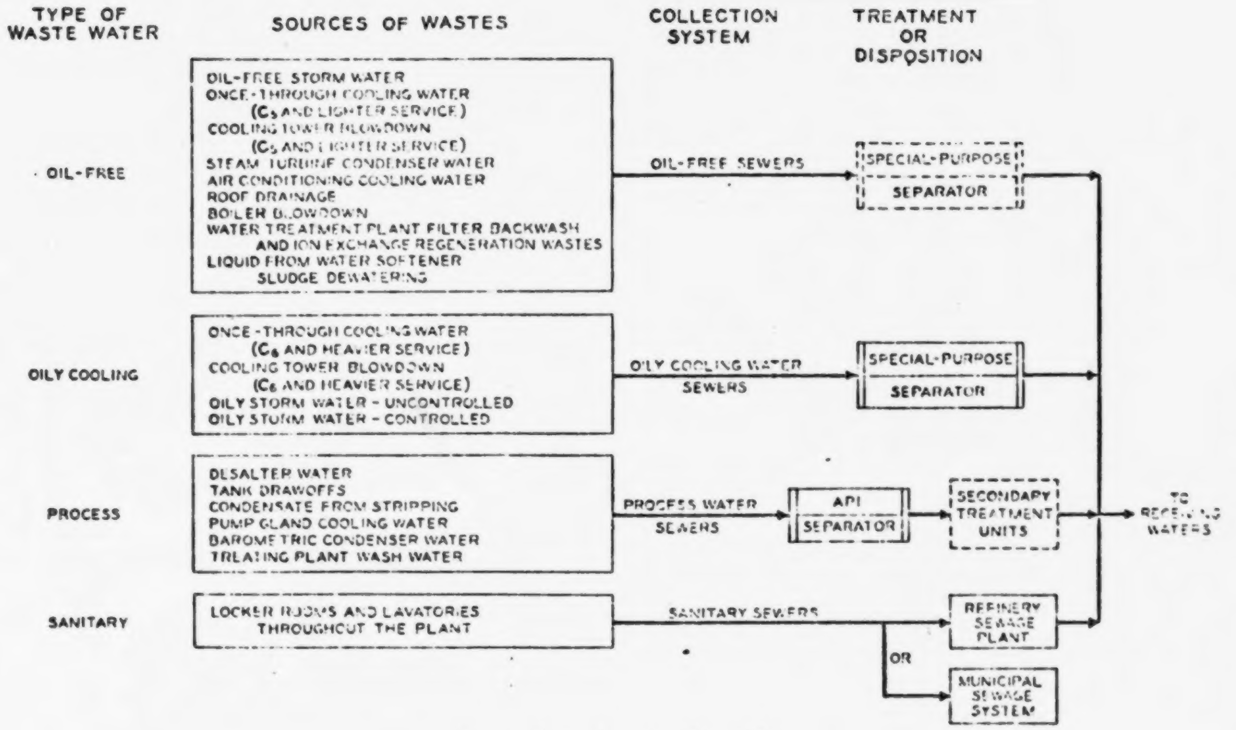
(1) Age of facility

(2) Type of process

(3) Availability of H_2O

(4) Whether one-time water use and discharge or direct or indirect air cooling and recycle. Greatest differences observed in this regard.

Exhibit F-XXXV
Example of a Plan for the Collection and Treatment of Refinery of Liquid Wastes


TYPE OF WASTE WATER
SOURCES OF WASTES
COLLECTION SYSTEM
TREATMENT OR DISPOSITION
OIL-FREE
OIL-FREE STORM WATER
ONCE-THROUGH COOLING WATER
(C_5 AND LIGHTER SERVICE)
COOLING TOWER BLOWDOWN
(C_5 AND LIGHTER SERVICE)
STEAM TURBINE CONDENSER WATER
AIR CONDITIONING COOLING WATER
ROOF DRAINAGE
BOILER BLOWDOWN
WATER TREATMENT PLANT FILTER BACKWASH AND ION EXCHANGE REGENERATION WASTES
LIQUID FROM WATER SOFTENER SLUDGE DEWATERING
OIL-FREE SEWERS
SPECIAL-PURPOSE SEPARATOR
OILY COOLING
ONCE-THROUGH COOLING WATER
(C_6 AND HEAVIER SERVICE)
COOLING TOWER BLOWDOWN
(C_6 AND HEAVIER SERVICE)
OILY STORM WATER - UNCONTROLLED
OILY STORM WATER - CONTROLLED
OILY COOLING WATER SEWERS
SPECIAL-PURPOSE SEPARATOR
PROCESS
DESALTER WATER
TANK DRAWOFFS
CONDENSATE FROM STRIPPING
PUMP GLAND COOLING WATER
BAROMETRIC CONDENSER WATER
TREATING PLANT WASH WATER
PROCESS WATER SEWERS
API SEPARATOR
SECONDARY TREATMENT UNITS
TO RECEIVING WATERS
SANITARY
LOCKER ROOMS AND LAVATORIES THROUGHOUT THE PLANT
SANITARY SEWERS
REFINERY SEWAGE PLANT
OR
MUNICIPAL SEWAGE SYSTEM

Source: American Petroleum Institute Manual on Disposal of Refinery Wastes, p 3-5, (1969).

3. Solid Wastes

   (a) Sludges containing water and solids; the quantities of these solids depend largely on the quality and quantity of raw water used.

   (b) Sludges containing oil, water, and solids

      (1) These sludges are primarily from API separators and consist of water, iron oxides and sulfides, sand, silt and clay obtained from the crude oil.

      (2) Other sources are tank bottom sludges and sludges from biological treatment processes

      (3) These solids present the most difficult solid waste disposal problems at a refinery

   (c) Biological solids from biological treatment processes

4. Noise Pollution: generally minimal

B. Indirect

1. Oil Drilling - impairs water quality and ecological balance (see MINING)

2. Auto Emissions

   Largest yield from crude oil - gasoline (approximately 46% in 1968). Gasoline in turn major source of air pollution from motor vehicles, particularly in terms of hydrocarbon and carbon monoxide emissions.

3. Storage and Transport

   a. Storage - significant air pollution emissions associated with tank farms and other storage mechanisms

   b. Transport

      (1) Pipelines - occasional ruptures and leaks can cause water pollution. Very unusual and magnitude of impact generally insignificant .

      (2) Tanker spills - major problem requiring special technologies to prevent future spills.

III. NON LAND USE VARIABLES

A. Management

1. Import Policies

   a. Recent removal of old import quota system in order to enable crude - short refiners to obtain raw material. Now can import unlimited crude oil for modest fee. Also 75% of fee being waived for new installations.

   b. Far-reaching implications for national security and enormous impact on balance of payments.

2. Licenses - President recommends frequent fee evaluation to maintain adequate incentive for construction and expansion of refineries

3. Product Specifications - e.g., octane requirements for gasoline

4. Tax Policies - President has proposed tax credit for exploratory drilling; could be extended to refinery expansions and construction of new facilities.

5. Conservation Programs - e.g., limitations on automobile gas consumption.

6. Refinery Conversion - change refinery processes requiring low sulfur (sweet) crude oil to ones that can use high sulfur (sour) crude which is available in much greater abundance.

7. Emergency Energy Legislation and policy set by Federal Energy Office.

B. Effective Maintenance

1. Effective maintenance, repair and replacement can help control emissions due to leaks from polymerization, alkylation and isomerization; from heating operations; from blending processes.

2. Effective maintenance, repair and replacement can also help reduce effluents.

C. Technology

1. Air Pollution

a. Magnitude of the problem

(1) EPA standards will require substantial reductions in emissions from petroleum refineries

Exhibit F-XXXVI
Emissions From Petroleum Refineries

	Emissions - Thousands of Tons Per Year			
Year	Hydro-Carbons	SO_x	Particulates	CO
1967	153	2,310	185	9,300
1977 W/O	197	3,010	241	12,100
1977 W/	12	20.8	98	--
reduction levels	(95%)	(99.5%)	(67%)	(100%)

(2) Reductions in emissions to comply with standards can be accomplished by technological means.

b. Vapor recovery systems - these systems are used to collect and dispose of waste gases, preventing harmful emission to the atmosphere. Gases collected can be directed to furnaces for combustion; gases with high sulfur content can be directed to sulfur recovery plants. Information is needed on costs of installation of different types of systems.

(1) Vapor recovery systems can reduce to negligible amounts emissions from the barometric condenser on the vacuum distillation column

(2) Vapor recovery systems for settling and surge tanks can help control emissions during the treating processes.

(3) Storage emissions during the blending operations can be minimized by use of vapor recovery systems

(4) Hydrocarbon emission from process drain can be reduced from 210 lb 'bbl waste waster to 8 lb/bbl waste water by use of vapor recovery systems

c. Electrostatic precipitators - these control measures are used on cracking unit regenerators to remove particulates. When installed on a fluid catalytic cracking unit, existing electrostatic precipitators used in combination with a CO boiler have been able to reduce (see below) particulate emissions from 93-340 lb/10^3 bbl fresh feed to 12.5-61.0 lb/10^3 bbl fresh feed. Efficiency of electrostatic precipitators varies with a number of factors, of which the plate area is particularly important. Efficiency of elestrostatic precipitators has been rated at between 90 and 95% for oil refineries, substantially below their efficiency in other industries. Proposed standards will allow particulate emissions of no more than 50 mg/Nm^3 (undiluted), or 0.022 gr/dscf and of no more than 20% capacity except for 3 minutes in any one hour. Existing precipitators seem to be able to reach the latter standard. The former which translates into about 6.2 lb/10^3 bbl fresh feed of particulates for a typical unit producing at 50,000 barrels a day fresh feed at a gas flow rate of 150,000 dscfm, will be much harder to comply with. (Particulate emissions from CO boilers are subtracted.) Costs of installing electrostatic precipitators run about $642,000 initial investment plus $128,000 annual expenditure for an average refinery. The alternative to precipitators--cyclones--are much less efficient.

d. Incinerator/waste heat boiler - this device is the most common method of controlling carbon monoxide emissions from catalyst cracking. Carbon monoxide emissions from an uncontrolled fluid catalytic cracking unit can be reduced from 13,700 lb/10^3 bbl fresh feed to negligible amounts by use of a CO boiler. The CO boiler is a source of particulate emissions; particulate emissions are expected to be especially high when fuel oil is used as an auxiliary fuel, but refinery fuel gas, normally used for refining, also is a source of particulates. Carbon monoxide boilers cost about $3,000,000 each.

e. Amine absorption systems - refinery processes such as distillation and fluid catalytic cracking produce gases that may be more than 5% hydrogen sulfide. Amine systems can be used to remove hydrogen sulfide from all refinery gases used to fire new boilers and heaters to reduce emissions of sulfur dioxide. Amine absorption systems can be used in conjunction with a sulfur recovery plant (Claus). Indications are that installation of amine systems would involve a 2-5% increase in investment cost but no evident increase in operating costs over existing amine systems to meet new standards.

f. Sulfur recovery plants (usually the Claus plant). Hydrogen sulfide absorbed by the amine solution in an amine system can be converted to elemental sulfur in a sulfur recovery plant. However, the market for such sulfur is not favorable and sulfur recovery has its own pollution problems in the tail gas. The most commonly used method of cleaning tail gas emissions is conversion of the tail gas back to H_2S and then to sulfur, but installation of such an abatement system is expensive. Less used methods for recovering tail gases would convert it to sulfuric acid, but this technology needs more work. Cost of sulfur recovery plants: 4 ton, less than $100,000; 100 ton, $630,000. Cost of cleaning mechanism for 100 ton plant: $378,000 investment, $103,600 annual expenditure.

2. Water Pollution

Substantial reductions in effluents would be required by new standards (see exhibits).

a. Better efficiencies in operations of air cooling and recycle systems will aid in meeting new requirements.

b. Refinement and expanded use of waste treatment systems will be necessary to meet limitations.

   (1) Biological treatment methods. While these are generally successful in removing major contaminants from waste water, pre-treatment removal of high concentrations of hydrogen sulfide, ammonia, and oil may be required.

   (2) Physical/chemical systems. The system has a number of advantages over the biological in that it is less sensitive to shock loads, can be easily expanded, and requires about 1/7 the land for operation. Cost is about the same, but its general applicability remains to be demonstrated.

Exhibit F-XXXVII
Effluent Limitations for All Refineries
(Pounds of Puliutant per 1,000 Barrels/Stream Day)

Refinery Class	NH_3 (N)	TOC (1)	BOD_5	COD	Cr^{+6}	Cr^t	O&G	Phenol	Sulfide	TSS
A	1.6	4.0	2.5	15.3	0.0008	0.041	1.66	0.017	0.028	3.3
B	3.3	8.0	5.0	30.6	0.0017	0.083	3.34	0.033	0.057	6.6
C	4.1	11.6	7.3	44.6	0.0021	0.104	4.18	0.042	0.071	8.3
D	5.0	16.0	10.0	61.0	0.0025	0.125	5.00	0.050	0.085	10.0
E	7.5	27.0	16.8	102.9	0.0038	0.187	7.50	0.075	0.128	15.0

(1) TOC is shown as a possible organic monitoring parameter. Either TOC or TOD may be used for estimating BOD, using an agreed correlation factor for the refinery.

Proposed Limitations - Refineries Using Recycle-Air Cooling

Exhibit F-XXXVIII
Effluent Limitations (BPCTCA) Recycle-Air Cooling Subcategory
(Pounds per 1,000 b/sd Capacity)

Refinery Class	NH_3 (N)	TOC	BOD_5	COD	Cr^{+6}	Cr^t	O&G	Phenol	Sulfide	TSS
A	1.0	2.4	1.5	9.2	0.0005	0.025	0.99	0.010	0.017	2.0
B	2.2	5.2	3.3	19.9	0.0011	0.054	2.17	0.021	0.037	4.3
C	1.9	5.3	3.4	20.5	0.0009	0.048	1.92	0.019	0.033	3.8
D	3.9	12.5	7.8	47.6	0.0019	0.098	3.90	0.039	0.066	7.8
E	2.9	10.5	6.6	40.0	0.0014	0.073	2.93	0.029	0.049	5.9

Class A Refinery limitations - recommended for all operations practicing recycle over 10,000 barrels/day. (refineries using saline or brackish water to be evaluated on individual basis)

Class D Refinery limitations - recommended for all remaining operations.

PETROLEUM REFINERY SITING

IV. LAND USE/LOCATIONAL STRATEGIES

A. Transportation appears to be the major factor in locational decisions.

   1. While location near navigable waters seems to be preferred, the favorable tariff structure of pipelines increases the viability of inland pipelines versus water transportation.

   2. While much of existing U.S. refinery capacity is concentrated in areas close to domestic or foreign crude sources as well as in close proximity to major markets for refined products, pipeline economics might encourage locating markets which are at some distance from crude sources, or at intermediate points.

B. Physical Constraints

   1. While fresh water is preferred, research is necessary into the feasibility of using salt water for operations has been shown in operations overseas.

   2. Meteorological--cooler climates can be more economical for refinery operations--reduction amount of water used in cooling tower operations; less evaporation--but may not necessarily be required.

C. Buffer zones at new refinery sites are desirable to minimize area impacted by air pollution emissions and by unpleasant visual aesthetics from refinery operations.

D. Locational Linkages - Large industrial users of petroleum products will site in close proximity to refineries.

   1. Secondary environmental impact--bears on non-degradation. Studies have been performed by ADL and RPA.

   2. Secondary impact on land use around actual site.

SUMMARY: PETROLEUM REFINERY SITING

1. Timing

   a. Over the next 10-12 years, a few new refineries will be constructed. As of January 1, 1972, three new refineries, two of which were scheduled to be operational by 1976, were under study, and three more were tentatively planned. As it takes 6-7 years lead time to refinery operation, any additional refineries currently in the planning stages will not be operational until the late 1970's or early 1980's. EPA may want to become involved in future planning efforts.

   b. Over the next 10-12 years, most refinery construction will be existing refinery expansion. As of January, 1972, 1,731,000 b/d to existing capacity, and further expansion was under consideration at several other locations.

2. Magnitude (i.e., degree to which the adverse environmental impacts associated with petroleum refinery siting can be controlled by non-land use vs. land use variables).

   a. Air pollution

      (1) Pollution control devices and effective maintenance can substantially reduce emissions. Particulate emissions will continue to be a problem, although EPA estimates reduction to about 1/2 1967 levels by 1977. CO emissions can be virtually eliminated.

   b. Water pollution

      (1) Effluents from one time water use in direct process contact will continue to be significant.

      (2) Efficient operation of air cooling and recycle systems and of non-direct contact once-through cooling water systems in conjunction with implementation of effluent treatment systems can substantially reduce effluents from most refineries.

      (3) In some instances, pollution abatement may entail major modifications of in-plant process units.

(4) If the plant has access to a large land area, substantial reductions in effluents can be realized by installation of long-residence time lagoon and/or activated sludge treatment facilities.

c. Aesthetic considerations, sight and smell

(1) Buffer zones can reduce

(2) Location of plants away from major population centers can reduce

3. Possible conflicts

a. Environmentalist arguments against petroleum refinery construction conflict with desirability of increasing domestic refinery capacity to meet rising demands for petroleum products.

b. Water pollution vs. air pollution

Land requirements of effluent treatment systems may conflict with desirability of buffer zones and with land requirements of such emission controls and sulfur recovery plants.

4. Chain effect

Existence of petroleum refineries in a particular local may attract petrochemical companies and other users of petroleum refinery products into the area, creating incentives for refinery expansion or new grass roots construction and necessitating further development of industrial infrastructure, including transportation facilities.

5. Rural vs. Urban

a. Savings in transporation make location in close proximity to markets -- industrial or population centers -- attractive, when markets for all refinery needs exist.

b. Competing land uses and potential irritation of refinery facilities to urban residents, however, force refineries to locate outside the core of densely populated areas.

c. Location near sources of supply desirable only when markets accessible, such as by tanker or by pipeline.

6. Concentration vs. Dispersion

a. Existing refineries are concentrated in the Gulf Coast Region, along the Atlantic Coast (New Jersey area), in the Midwestern states of Illinois, Indiana, and Ohio, and in California.

b. Preference of producers for expansion over new plant construction suggests that much of future expansion of U.S. petroleum refinery capacity will be in areas in which refinery capacity is already concentrated.

c. Substantial linkages among large industrial users of petroleum products and between them and petroleum refineries suggests future expansion of petroleum refining capacity in such areas as the Gulf Coast where large concentrations of industrial users already exist.

d. Preference for coastal areas could see future refinery construction in coastal areas not yet crowded, provided that there are potential markets to be exploited, as well as in areas already devoted to industrial use.

7. Non-degradation

a. Possibility of future refinery construction in coastal areas as yet not turned over to industrial use. Possibility exists that major industrial users would follow refineries into the areas.

b. Possibility of future refinery construction in rural areas in fairly close proximity to metropolitan areas or between major metropolitan areas.

c. Possibility of non-degradation becoming an issue for water.

Appendix F
Part 4: TANK FARM PETROLEUM - STORAGE VESSEL SITING

I. NEEDS

A. The number of new storage tanks constructed depends on:

- --physical refinery requirements dictated by land and siting
- --the growth rate of crude oil refining and gasoline production (annual growth of 4 percent projected)
- --the number of different products, which must occupy different tanks
- --the size of the tanks constructed
- --the need to maintain constant throughput

B. Total petroleum production is expected to increase by 4.1% - 4.5% each year from 1970-1980. The trends for the three major products are as follows:[1]

Crude oil refining and gasoline production will require storage for 20,900,000 barrels of crude oil and 12,500,000 barrels of gasoline annually over the next five years. Based on a per tank capacity of 71,428 barrels of gasoline and 49,762 barrels of crude oil, it is estimated that 175 new gasoline storage tanks and 420 new crude oil storage tanks will be constructed each year inside the United States.

Jet fuel consumption is expected to stabilize over the next five years, thereby resulting in a negligible growth rate in this area.

At an annual growth rate of 3% over the next five years, storage for 7,300,000 additional barrels of distillate fuel will be required each year. Based on the 1969 average tank size of 50,000 barrels, 146 new tanks will be needed.

C. Land Consumption

Every refinery in the United States has an adjacent tank farm. The proportionate use of land for an oil refinery breaks down approximately as follows:

- Process area--10%
- Buffer zone--25%
- Storage area--65%

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[1] Unless otherwise specified, the information material used here is drawn from EPA, Background Information for Proposed New Source Performance Standards, APTD-1352a, Vol. 1, June 1973, pp. 31-36, and Compilation of Air Pollution Emmission Factors, AP-42, second edition, pp. 4.3-4-4.3-2.

Therefore, if a plant which produces 160,000 B/D sits on 250 acres, approximately 162 acres of that land will be used for storage.

1. The amount of storage area needed depends on the method of shipping and receiving oil. Oil transported by pipeline does not require much storage space; oil transported by large tankers necessitates a great deal of storage space.

2. An important factor in consideration of storage trends for the petroleum industry is tank size. While in the past the average tank has held 20,000 to 80,000 barrels, refineries are currently building tanks which hold from 100,000 to 500,000 barrels. Gulf Oil had 2-3 tanks with a capacity of 550,000 barrels and cites the economies of construction as the major consideration.[1] A few large tanks are also likely to use less space than a greater number of smaller tanks.

3. Deepwater ports are coming into use for the storage of petroleum products.

    a. In designing these facilities it has been suggested that giant supertanks be located off-shore to receive supplies off-loaded from the ocean vessels. It is further proposed that these tanks be used jointly by several oil companies.

    b. If this concept is put into practice, substantial landspace economies could be realized.

II. ENVIRONMENTAL IMPACT

A. Direct Impact

1. Air Pollution

a. Hydrocarbon Evaporation

(i) Hydrocarbon emissions through evaporation occur from the storage and handling of crude oil and products. A majority of these emissions react in the atmosphere to form photochemical oxidants. These losses may be classified into three types:

--Breathing losses (from fixed-roof tanks). Hydrocarbon vapors are expelled by expansion of existing vapors due to increases in temperature or decreases in barometric pressure.

--Working losses (from fixed-roof tanks) during emptying or filling operations. Emptying losses result from vapor expansion caused by vaporization after product withdrawal; filling losses result as vapor is vented to the atmosphere by displacement in the amount about equal to the volume of input liquid.

--Standing storage losses (from floating-roof tanks). Losses result from the escape of vapors through the seal system between the floating room and the tank wall, the hatches, glands, valves, fittings, and other openings.

(ii) The quantity of evaporation losses depend on such factors as the type of product stored (gasoline or crude oil), vapor pressure of the stored product, average temperature of the stored product, tank diameter and construction, color of tank paint, and average wind velocity of the area.

(iii) Working losses and breathing losses can be significant. Average hydrocarbon emission factors for these types of losses are summarized in Exhibit F-XXXIX.

(iv) Under current control levels, annual hydrocarbon emission from crude oil, gasoline, and distillage tanks are estimated at 1.3 million tons, or about 3 percent of the total national hydrocarbon emissions and about 7 percent of the 18.6 million tons/year emitted from all stationary sources. Hydrocarbon emissions from new tanks, using current control levels, are projected to amount to 41,000 tons/year.

EXHIBIT F-XXXIX

HYDROCARBON EMISSION FACTORS FOR EVAPORATION LOSSES FROM THE STORAGE OF PETROLEUM PRODUCTS

EMISSION FACTOR RATING: C

		Type of material stored	
Type of tank[a]	Units	Gasoline or finished petroleum product	Crude oil
Fixed roof			
Breathing loss[b]	lb/day-1000 gal storage capacity	0.4	0.3
	kg/day-1000 liters storage capacity	0.05	0.04
Working loss[b,c]	lb/1000 gal throughput	11	8
	kg/1000 liters throughput	1.32	0.96
Floating roof			
Breathing loss[d]	lb/day-tank	140(40 to 210)[e]	100(30 to 160)[f]
	kg/day-tank	63.5	45.4
Working loss[d]	lb/1000 gal throughput	Neg	Neg
	kg/1000 liters throughput	Neg	Neg

[a] For tanks equipped with vapor-recovery systems, emissions are negligible.[4]

[b] Reference 1.

[c] An average turnover rate for petroleum storage is approximately 6.[4] Thus, the throughput is equal to 6 times the capacity.

[d] Reference 3.

[e] 140 (63.5) based on average conditions and tank diameter of 100 ft (30.5 m); use 40 (18.1 kg) for smaller tanks, 50 ft (15.3 m) diameter; use 210 (95 kg) for larger tanks, 150 ft (45.8 m) diameter.

[f] Use 30 (13.6 kg) for smaller tanks, 50 ft (15.3 m) diameter; use 160 (72.5 kg) for larger tanks, 150 ft (45.8m) diameter.

b. Fires. In 1969 petroleum tank farm properties numbered a total of 250. In that year, four fires originated in these properties (all confined on the property).[1] Supertanks stored on land will pose an increasing threat for the potential scope and danger of fires.

2. Water Pollution (oil pollution)

a. Ruptured tankers and tanks stored in deepwater ports, levee and dike failures, pipeline leaks and breaks, and lack of care during transfers (e.g., tank overflows) cause oil spill contamination of coastal and inland waters with far reaching damage potential to fishing resources and other marine life, human health, recreational and other shore facilities, and aesthetic value.

b. Danger of groundwater contamination accompanies land disposal of recovered slicks or sludge.

c. Accumulated drainage from a facility ground has oil content.

B. Indirect Impact

1. Petroleum products stored at waterside tank facilities are distributed to inland points via pipeline, railroad and tank trucks, in the process posing potential hazard of oil spills and leaks.

2. Transportation by tankers and barges of petroleum products now account for over 40 percent of the total U.S. waterborne tonnage, moving over 1 million tons daily through the nation's coastal and inland waters.

a. These tankers and barges constitute a leading source of oil pollution through the discharging of oil by overboard disposal of tank cleaning and ballasting water and bilge pumping.

b. Although relatively rare, spills from tanker casualties, e.g., grounding, collision, are a real danger in crowded harbor waters. As the size of new tankers increased rapidly, the tank sizes have grown while decreasing maneuverability.

c. The U.S. Department of Interior estimates that 28% of the ocean oil pollution is from tankers and oil barges.

III. NON-LAND USE VARIABLES AFFECTING POLLUTION IMPACT

A. Technologies

1. Hydrocarbon evaporation control

a. EPA's New Source Performance Standard (NSPS) is designed to reduce by 80 percent the hydrocarbon emission that would result from new tanks (used for the storage of gasoline crude oil, or petroleum distillates) when lifted to current control levels, i.e. from 41,000 tons/ year to 7,700 tons/ year. To attain this EPA suggests the application of the following measures for new storage tanks with capacities greater than 245,000 liters or 65,000 gallons:[1]

(i) No more than 78 mm Hg or 1.52 psia (pounds per square inch absolute[2]) can be stored in fixed-roof tanks, equipped with a conservation vent or equivalent. This category applies to less volatile distillate fuel oils, kerosenes, heavy catalytic cracked naphthas, and heavy crude and residual oils.

(ii) More than 78 mm Hg but not more than 570 mm Hg or 11.1 psia must be equipped with a floating roof or the equivalent.

(iii) More than 570 mm must be equipped with a vapor recovery system, pressure storage, or refrigeration. The materials having such vapor pressure include certain volatile winter-grade northern gasolines and volatile gasoline-blending components that are temporarily stored by the refineries of the Gulf Coast previous to shipment north.

These means for reducing hydrocarbon emissions conserve and increase the yield of the stored products.

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[1] EPA's decision on this capacity size is based on the following findings: 1. Tanks with capacities greater than 65,000 gallons account for over 95 percent of hydrocarbon emissions from storage tanks; 2. Few tanks with capacities smaller than 65,000 gallons are expected to be constructed for the storing of gasoline, crude oil or petroleum distillates; 3. The relative cost of control devices increases sharply at the lower capacities.

[2] Measures of the true vapor pressure.

b. Costs of Control Measures

(i) The investment cost in a floating roof, proposed for storage of crude oil or products with a true vapor pressure greater than 1.52 psia, is 12 to 25 percent higher than that in a fixed roof.

(ii) The savings resulting from the recovery are estimated to exceed these extra expenditures for tanks larger than 20,000 barrel capacity. Exhibit F-XL lists the incremental investment cost over a fixed roof and the annual cost or savings that will result from a floating roof installation.

EXHIBIT F-XL

CONTROL COSTS FOR
PETROLEUM STORAGE TANKS

Tank capacity, bbl	Incremental investment cost above cone-roof tank, $	Material stored	Annual cost, $	
20,000	20,000	Gasoline	savings	1,140[a]
		Crude oil		480
		Jet naphtha		2,100
80,000	27,000	Gasoline	savings	11,100
		Crude oil	savings	5,200
		Jet naphtha		1,000

[a] Savings from the product recovered exceed the annualized cost.

(iii) The vapor recovery system enables a 7 percent incremental recovery over a floating-roof tank with a 50,000 barrel capacity. However, the system is more costly, and in terms of its cost divided by the size of recovered product, the cost per barrel amounts to 20 times that for the floating roof.

2. Prevention and Control of Oil Spills

a. Oil companies use the solid booms (oil containment devices) around unloading terminals as a routine precaution.

b. Dikes and levees are constructed around the batteries of storage tanks to contain spillage to the surrounding area and against flooding by high water.

c. For the control of the oil-containing drainage against spreading beyond the tank farm area, oil trap and other removal systems may be installed.

d. Preventive, control and clean-up measures of tanker-related oil spills.

(i) Instead of overboard discharge of the tank cleaning and ballasting water, tankers take any of the following measures:

--Carry the tank cleaning and ballasting water to separator facilities at refineries onshore.

--Employ the "load on top" method, whereby oil is loaded ontop of the tank cleaning and ballasting water.

--Equip the tanker with oil-water separators.

--Build separate ballast tanks, eliminating the need for cargo-tank ballasting.

(ii) Prevention of tanker casualties:

--Shore-based navigation communications.

--On-board navigational equipment, including sonar and radar.

--Assigning of traffic lanes.

(iii) Ship construction improvements to prevent oil spill discharge.

--Improvement in crash-stop maneuver.

--Improvements in reversing characteristics.

--Structural barriers at the ship's side and reinforced bottoms.

(iv) Various technologies have been developed and continue to be developed for control and cleanup of oil spills. These include booms of various types to contain oil slicks, skimmer boats to collect them, collecting agents, sinking agents, getting and congealing agents, and burning agents. At the same time, unless properly applied, use of some of the chemical materials can result in the extermination of marine life in the area and considerable damage to shore areas. For example, chemical dispersion agents, such as detergents, are 30 times as toxic as oil.

IV. LAND USE FACTORS

A. There are two major trends--the implications have yet to be determined--that will lead to a conclusion regarding whether the siting of storage vessels is a land use issue:

1. What will be the environmental impact of land- or water-sited supertanks?

2. What is the trend towards replacing relatively large coastal tank farms with pipeline systems that transport the oil inland to a number of tanks at scatter locations (e.g. as is currently being proposed for Long Island)?

SUMMARY
TANK FARM STORAGE VESSEL SITING

1. Timing

   --Annually over the next 10 years, there will be a substantial need for additional storage capacity for crude oil, gasoline, and distillate fuel oil.

2. Magnitude (that is, degree to which the environmental control problem or impact from siting is solved by non-land use versus land use variables)

   a. Non land use variables

      (1) Engineering techniques for control of hydrocarbon emissions are available and are used currently. The annual savings generated by floating roofs for gasoline and crude oil storage justify their incremental cost.

      (2) The capital costs of vapor recovery systems are quite high, but the technology is available and usable.

      (3) Some emissions will continue to occur for the next 10-15 years since floating roofs do not eliminate the emissions.

      (4) Technology is improving to reduce oil spills; loading and unloading equipment is improved; tankers are improved; companies are more careful due to fear of publicity. Spills have not been completely eliminated, however.

   b. Land use variables: siting of storage vessel is land use and location related

      (1) Siting is near refineries and near markets.

      (2) Amount of storage necessary depends on transportation of crude or refined product; refineries or markets served by tanker thus near navigable water rather than pipeline; need substantial storage space.

      (3) Due to real or perceived nuisance associated with tank farms, its siting can be incompatible with surrounding land uses.

      (4) Use of giant tanks and deep water ports can reduce amount of land needed for storage space.

3. Irreversibility

   a. Oil spillage damage.

   b. Land use impact: once settled it is difficult to remove storage vessel facilities.

   c. Storage vessels and the refineries they serve involve large capital investment.

4. Possible benefits or conflicts

   a. Siting of tank farms relates directly to EPA's water pollution control objective.

   b. Control of tankers and their loading and unloading also relates to water pollution control objectives.

5. Chain Effect

   a. Availability of storage sites is an important factor in construction of needed refineries.

   b. Storage space site is an important aspect of cost and availability of supply for markets of gasoline and distillate fuel.

6. Rural vs. Urban

   --Generally the storage siting must fulfill needs of refinery or large market. Because of substantial space requirements, it cannot be in the middle of urban centers, yet it cannot be far away from urban locations, since the refinery will have substantial labor requirements.

7. Concentration vs. Dispersion

   --Economies of scale are utilized in building very large storage vessels. Siting for such large vessels will reduce land requirements too. Common usage of supertanks at deep water ports will also conserve land.

8. Nondegradation

   --Air pollution and water pollution from tank farm growth and tanker growth contributes to the degradation of the ambient air quality and potential water pollution, particularly in urban locations.

Appendix G
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